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RECEIVED

March 10, 2003 MAR 11 2003

REGULATORY DIVISION

By Facsimile and First Class Mail

Karen Adams, Chief
Permits and Enforcement Branch
U.S. Army Corps of Engineers
Regulatory Division
696 Virginia Road
Concord, Massachusetts 01742

Re: Cape Wind Project -- Scope of Alternatives Analysis Under NEPA

Dear Ms. Adams:

Cape Wind Associates, LLC ("Cape Wind") understands that a question has arisen concerning the extent to which the National Environmental Policy Act ("NEPA"), 42 U.S.C. § 4321, *et seq.*, requires the U.S. Army Corps of Engineers (the "Corps") to identify, screen and evaluate "alternatives" to the proposed Cape Wind Project in the Environmental Impact Statement ("EIS") being prepared by the Corps. On behalf of my client, Cape Wind, this letter provides information that addresses that question.

Federal courts consistently have held that NEPA *does not* require a federal agency to analyze, in the same level of detail as the applicant's "proposed action," any minimum number of alternatives in an EIS. Instead, as discussed below and under facts similar to those present here, Federal courts have upheld EISs that briefly examined and rejected, through an initial screening process, each of the alternatives under consideration, and accordingly performed a detailed evaluation on only (a) the proposed action, or (b) the proposed action and the no action alternative. The law on this point is both conclusive and well-settled.

NEPA requires a Federal agency in an EIS to "[r]igorously explore and objectively evaluate all reasonable alternatives [to a proposed action], and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." 40 C.F.R. § 1502.14(a). NEPA's "'rule of reason' guides both the choice of alternatives as well as the extent to which the Environmental Impact Statement must discuss each alternative." *Citizens Against Burlington, Inc. v. Busey,* 938 F.2d 190, 195 (D.C. Cir. 1991) ("If, therefore, the consideration of alternatives is to inform both the public and the agency decisionmaker, the discussion must be moored to 'some notion of feasibility.'" *Id.* (quoting *Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc.*, 435 U.S. 519, 551 (1978)).

It is well-settled that the "range of reasonable alternatives is 'dictated by the nature and scope of the proposed action.'" *Strahan v. Linnon*, 967 F. Supp. 581, 602 (D.Mass. 1997) (quoting *City of Carmel-By-The-Sea v. U.S. Dept. of Transportation*, 95 F.3d 892, 903 (9th Cir. 1996). NEPA envisions that a federal agency will first identify and initially screen a wide range of alternatives to a proposed action, and then conduct a more detailed environmental evaluation of only those alternatives that are not rejected by the screening process (that is, the "reasonable" alternatives"). In this regard, the First Circuit Court of Appeals has stated that "no purpose would be served by requiring [an agency] to study exhaustively all environmental impacts at each alternative site considered once it has reasonable concluded that none of the alternatives would be substantially preferable to the proposed site." *Roosevelt Campobello International Park Commission v. U.S. Environmental Protection Agency*, 684 F.2d 1041, 1047 (1st Cir. 1982) (Emphasis added). *See also City of Bridgeton v. FAA*, 212 F.3d 448, 456 (8th Cir. 2000) ("An alternative that does not accomplish the purpose of the project in question is *un* reasonable and does not require detailed attention in the FEIS.") (emphasis in original).[1]

Based on this reasoning, the Federal courts consistently have upheld EISs which eliminated (through an initial screening process) each of the alternatives under consideration, and accordingly conducted a detailed environmental review of only: (a) the proposed action; (b) the proposed action and the no-action alternative; and/or (c) the proposed action, the no-action alternative, and alternatives which primarily were "variations" to the proposed action. Examples of these decisions include the following.

- *Tongass Conservation Society v. Cheney*, 924 F.2d 1137, 1138-1141 (D.C. Cir. 1991), which upheld as reasonable an EIS prepared by the Navy which, after initially screening and rejecting 13 of the 14 alternatives under consideration as not feasible, evaluated in detail only the "preferred alternative." In reaching this determination, the court concurred with the Navy's reasoning that "because the [proposed action] was the only feasible site, there was no reasonable alternative to evaluate; hence the EIS need only to have briefly discussed why the other preliminarily screened sites were not reasonable alternatives." *Id.*

- *Strahan v. Linnon*, 967 F. Supp. 581, 602-603 (D.Mass 1997), which upheld the Coast Guard's detailed analysis of only the "no action" alternative and the proposed action (the "APLMR Initiative") in its Final EIS. The court noted with approval that the "FEIS demonstrates a detailed comparison of the 'No Action Alternative' and the 'Preferred Alternative,' evaluating factors such as the potential impact on the physical, biological, and socioeconomic environments. ... [T]he FEIS also briefly

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1 Of interest here, the First Circuit has warned that "*Vermont Yankee* makes it clear that the NEPA requirement of studying alternatives may not be turned into a game to be played by persons who – for whatever reasons and with whatever depth of conviction – are chiefly interested in scuttling a particular project. There would be no end to the alternatives that would be proposed if opponents had no obligation to do more than make a facially plausible suggestion that a particular alternative might be of interest, and could then, after awaiting the results, find reasons why the agency's survey was inadequate." *Seacoast Anti-Pollution v. Nuclear Regulatory Commission*, 598 F.2d 1221, 1230-31 (1st Cir. 1979) (emphasis added).

evaluates and explains its reasons for rejecting [other alternatives]. ... I find that the discussion of alternatives, combined with the detailed response to comments is sufficient to trigger such judicial deference." *Id.*

- *Carmel-By-The-Sea v. U.S. Dept. of Transportation,* 123 F.3d 1142, 1157-1159 (9th Cir. 1997), upholding the U.S. Department of Transportation's ("DOT") decision to limit its detailed consideration of alternatives to the "no action" alternative and other alternatives which primarily were variations to the "proposed action." After determining that "[a]ll of the alternatives considered ..., aside from the "no action" proposal, sought either to expand Highway 1, or to build a new freeway through Hatton Canyon," the court decided that the "Draft [EIS] had previously considered and rejected several other proposals .... These proposals span the spectrum of "reasonable" alternatives and satisfied the requirements of [NEPA]." *Id.*

- *Laguna Greenbelt, Inc. v. U.S. Dept. of Transportation,* 42 F.3d 517, 523-524 (9th Cir. 1994), which determined that the DOT could, after considering and rejecting a number of alternatives during an initial screening process, evaluate in detail only the "no action" alternative, the "preferred alternative," and a variation to the "preferred alternative." In reaching this decision, the Court observed that "the EIS discusses in detail two build alternatives: the proposed corridor ... and a second option following the same alignment and having the same general lane configuration .... The EIS also discusses a third option, the no-build alternative. In addition, the EIS discusses six categories of alternatives that were evaluated in earlier environmental documents and or in the course of the [EIS] but were eliminated from more detailed analysis and ultimately rejected." *Id.* The court then determined that all six categories of alternatives "were rejected as not feasible or failing to meet to project's objective .... Thus, the EIS discusses in detail all the alternatives that were feasible and briefly discusses the reasons that others were eliminated. <u>This is all NEPA requires – there is no minimum number of alternatives that must be discussed.</u>" *Id.* (emphasis added).

I understand that the Corps' EIS will identify and screen a number of alternatives, including the no action alternative, to the Cape Wind Project to determine whether any are reasonable and should be evaluated in further detail. The precedent identified above establishes conclusively that there is no 'minimum number" of alternatives that must successfully pass the initial screening process in the EIS so as to require further evaluation. Instead, provided the Corps fully articulates its reasoning, it would be proper for the Corps to eliminate the potential alternatives to the Project through an initial screening process, and fully evaluate in detail in the EIS only (a) the proposed action, (b) the proposed action and the no action alternative, or (c) the proposed action and alternatives which may constitute "variations" to the proposed actions.

Sincerely,

Mark C. Kalpin

Mark C. Kalpin

Range of Alternatives

- Practical & feasible in light of the underlying purpose & need for the proposal
- Not require costly & time-consuming evaluation of conjectural alternatives

Commercial scale

- Applicant proposed 420 MW facility
  - » Recent projects in ISO-NE area range 200-1500MW
  - » Corps has looked at +/-20% as reasonable for previous projects
  - » Example: strip mall not considered a reasonable alternative to a regional shopping mall

Adams, Karen K NAE

From: Dennis Duffy [dduffy@emienergy.com]
Sent: Monday, October 20, 2003 3:05 PM
To: Karen Kirk Adams (E-mail)
Cc: arthur.pugsley@state.ma.us; barry.drucker@mms.gov; deerin.babb-brot@state.ma.us; pdascombe@capecodcommission.org; jane.meade@state.ma.us; al.benson@hq.doe.gov; timmerman.timothy@epamail.epa.gov; moskal_john@epamail.epa.gov
Subject: Comments to Draft Alternatives Analysis

Cape Wind wishes to reply briefly to Tim's alternatives comments of October 9. It has been suggested that the basic approach of the alternatives analysis should now be revised because of a statement reportedly made by Jim Manwell that "a 100 mw offshore project could be commercially viable." As set forth below, such a revision is not appropriate.

First, the factual premise for the comment is incorrect. Professor Manwell has confirmed to us that he did not opine that a 100 mw offhsore project could be viable for New England. What he did say may have been taken out of context, and may refer to economic viability under European conditions and market supports, which are not relevant to the American situation.

Second, and in any event, a 100 mw facility would be too far removed from our commercial purpose of constructing a major 420 mw facility, with the economies of scale that would allow a more substantial (i.e., not the smallest possible) contribution to the region's electric supply portfolio and air quality, through sales into New England's competitive energy markets. It is well settled under NEPA that the business goals of a private applicant should be taken into account and, in the words of Judge Clarence Thomas, "Congress did not expect agencies to determine for the applicant what the goals of the applicant's [commercial] proposal should be."

Sincerely,

Dennis J. Duffy
Cape Wind Associates
617-904-3100, x.112

CAPE COD COMMISSION

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October 9, 2003

Ms. Karen Adams
U.S. Army Corps of Engineers
New England Division
696 Virginia Road
Concord, MA 01742-2751

RE: EIS Alternatives

Dear Ms Adams:

Thank you for the opportunity to participate in the inter-agency meeting at your offices on September 24, 2003 to discuss the alternatives and screening criteria for the Cape Wind Environmental Impact Statement (EIS). The following comments are those of the Commission staff as the Commission subcommittee has not reviewed the materials distributed at the September 24th meeting regarding the Corps approach to the EIS alternatives analysis, and in regard to the draft Peer Review comments and EIS appendices. The Commission staff continues to look forward to assisting the Corps in developing a thorough and objective EIS for this project.

Meeting Notes
We have received the draft notes of the September 24, 2003 meeting and in general believe they reflect the gist of much of the discussion. At the meeting, agencies represented were asked to comment on whether the sites under consideration were appropriate or could be excluded from further analysis. Commission staff at the meeting felt uncomfortable with commenting on many of these sites, particularly as the exact locus was undefined and that the participants had no opportunity to conduct their own assessment of the constraints for each site. There was also some disagreement on whether some of the identified constraints were accurate. For example, some questioned whether navigation issues for shipping at New Bedford would eliminate that site from consideration. Speaking for the Commission staff only, the fact that few comments were offered for individual sites at the meeting was more a reflection of a lack of information than a signal of agreement. Therefore, we would suggest that where it is indicated that there was a consensus or agreement, it should be clear that there was only partial agreement among the participants.

Alternative Sites/Flexible application of Screening Criteria
The Commission staff support the Corps recent more flexible application of the screening criteria for the alternatives analysis portion of the DEIS, rather than the pass/fail application previously proposed. In addition, we believe that the analysis of

representative alternatives has merit for such a complex project and that as a broad concept, this approach is worth pursuing. In principal at least, this approach would seem to allow for a broader range of alternatives (and their relative impacts) to be evaluated in the DEIS. However, Commission staff have some concerns over the steps taken to arrive at the representative sites.

We are concerned that the list of alternatives has not been developed by any methodical analysis of viable wind sites in New England. Instead, the sites under consideration have been accumulated via suggestions made at meetings based on independent knowledge. While this has certainly identified potential sites, the methodology could be open to criticism in that it does not objectively look at the region as a whole. We recognize the difficulty in evaluating a large, geographical area such as New England, however, it seems that such an exercise is vital in order for the EIS Alternative Analysis to be supportable. An approach that would potentially address this concern was suggested by the Peer Review group: "What would be helpful would be some analysis showing areas in New England with the required wind speed, the amount of land required, and the cost of transmission upgrades needed for grid access." This would clearly provide an objective base for the start of the analysis, from which the screening criteria could be applied.

Additional Suggestions

We are encouraged by the consideration of multiple sites as an alternative to a single, large facility. We strongly believe that distributed facilities have many benefits, not the least of which is the potential for easier integration into the transmission system and potentially lesser environmental impacts. However, as we have commented in earlier correspondence, we don't believe that close geographical proximity is necessarily an appropriate factor when considering multiple sites, although it may affect the economic return on the project. Therefore, we would suggest that this constraint be reconsidered.

Based on the discussions at the September 24th meeting and the meeting we attended in Boston on September 29 and 30 sponsored by the Dept of Energy, it seems that a potential combination of sites worth considering would be a combination of Boston Harbor and New Bedford. The National Park Service has already begun a process of evaluating wind turbines in the Boston Harbor Islands Recreation Area and the Town of Hull is considering placing additional turbines offshore in the vicinity. It also appeared from the US Coast Guard that there would be room for turbines outside the navigational channels of New Bedford. This combination of smaller deployments would provide a more urban setting for offshore facilities and may in combination reach the lower end of the range of facilities.

Furthermore, as we have suggested in prior correspondence, we believe the following alternatives should also be considered:

- Smaller facilities (i.e. fewer turbines) at Horseshoe Shoals
- Alternative design configurations that may have less visual impact. For instance, the Middlegrunden facility was redesigned to be more visually pleasing. It would be useful to have an analysis of different sized turbines, particularly in locations closest to shore, that would potentially have less visual impact and keep the capacity within the range under consideration.

- An analysis of whether choosing the largest machines available makes the most efficient use of the wind resource, at least as weighed against the watersheet area occupied, prevailing versus average wind conditions, turbine spacing, rotor diameter and visual impacts. For example, could a smaller turbine or rotor that operates at lower wind speeds produce sufficient energy to make a project viable and have less visual impacts and occupy less area of the Sound? Cape Wind is proposing to use the largest turbine currently available to maximize return on investment. The EIS should provide an assessment of whether this approach is in the public interest.

Peer Review Summary

With reference to the Draft EIS conclusions on alternatives, the Peer Review Summary notes that "there are many cases where the logic used to reach these conclusions is either flawed or is stretching reality" and that it "has the appearance of being written by advocates for the project rather than the USACE". The aim of the EIS is to provide unbiased and objective information, and as such, even the appearance of a conflict or subjectivity can severely undermine the integrity of the process. It is currently unclear to what extent the Peer Reviewers comments will be embraced, but our hope is that the Corps is able to remedy the situation by presenting a balanced view of the complex information available.

This comment could also be made in relation to the application of the screening criteria, and the Commission staff would suggest that the Corps make every effort to consistently apply the selected criteria. For instance, navigational issues and proximity to shipping lanes and flight paths are raised as constraints for a number of offshore sites, although they are not listed under the screening criteria and no description of what constitutes a conflict is included. In contrast, Table 3-6 which deals with the three Nantucket Sound sites, repeatedly references "minimal conflicts" with shipping and aviation for those sites, but provides no discussion of what constitutes a minimal conflict. At face value, it seems that this criterion has not been evenly applied and it would therefore be appropriate to expand on how the criteria are applied and the parameters of each.

As a number of independent sources have confirmed, including the Peer Reviewers, the relevance of these criteria <u>depends</u> on many factors. By some estimates an offshore project could be viable with as little as 100MW (or less) capacity. As the Commission pointed out in our December 19, 2003 letter, this figure is in sharp contrast to Cape Wind's capacity and the range of projects under consideration in the EIS (200MW-1,500MW). It is perhaps more appropriate for the range of facilities under consideration to be based on what is economically feasible for renewable facilities, rather than what has historically been connected to ISO-New England's grid. We have continually commented that the range currently being used is inappropriate to the project purpose and need. This concern seems to be shared by the Peer Reviewers who felt "that there are "utility scale" wind projects less than 200MW" and that "Many wind power plants with capacities under 100MW are installed in the US". We strongly recommend that the Corps reconsider whether this range is appropriate.

The size of the project has a direct bearing on the application of a number of the screening criteria, most notably the transmission surplus and land/watersheet area needed. At the September 24th meeting, many sites were shown to have insufficient capacity or available area to accommodate the range established (200-1,500 MW). However, this analysis would be different if a smaller area was needed and if a smaller surplus in the transmission capacity was applied. As mentioned in the Peer Review Summary, there are also some rules of thumb applied to this analysis (particularly regarding turbine spacing, rotor diameter and available area) that may be flawed which would further affect the viability of alternative sites. Therefore it seems that elimination of some sites at this stage may be premature, given the comments made by the Peer Review group.

A common thread that runs throughout the Peer Review summary refers to the economic considerations in developing this kind of project. These factors have a direct bearing on the applicability of the screening criteria. For instance, the economic viability of a project is as much related to the financier's return on investment, as it is to wind speed, water depth, land/water area and distance from shore, etc. Therefore, the EIS should also include a broad and generalized economic feasibility analysis for an offshore wind farm that is not specific to Cape Wind to provide an insight into these issues. This should include a detailed discussion of how the price paid for energy and "green attributes" affect the economic viability of a project and how wind resource relates to this analysis.

The Peer Review summary also raises a significant issue related to the long-term viability of the project and that should the project fail, it would be "the worst possible environmental outcome." It seems that this would also be the worst possible outcome for the emerging offshore wind energy industry, renewable energy advocates in general and for the users and neighbors of Nantucket Sound. This concern is shared by many and should be addressed in the EIS for this experimental technology. A "failed, bankrupt project" at the location selected by Cape Wind is likely to set renewable wind energy development back for decades and thus it is imperative that provision be made to address this issue. For instance, a phased installation would provide some degree of testing for the technology and would be consistent with the precautionary approach to emerging technologies. Similarly, although bonding for removal/decommissioning is traditionally a mechanism for dealing with abandoned facilities, it seems unlikely that Cape Wind would be willing to provide a bond sufficient to ensure complete site restoration.

We hope that the Corps will give careful consideration to the comments made by the Peer Review group as the Draft EIS is prepared, thank you for the opportunity to comment.

Sincerely,

Margo Fenn,
Executive Director,
Cape Cod Commission

cc: Cape Cod Commission Subcommittee Members (Aitchison, Ansel, Broidrick, Kadar, Taylor, Virgilio)
Leonard Fagan, Cape Wind Associates, LLC, 75 Arlington Street, Suite 704, Boston, MA 02116.
Charlie Natalie, ESS Inc., 888 Worcester Street, Suite 240, Wellesley, MA 02482

Arthur Pugsley, EOEA – MEPA Unit, 251 Causeway Street, Suite 900, Boston, MA 02114
Jane Mead, Massachusetts Coastal Zone Management, 251 Causeway Street, Suite 900, Boston, MA 02114
Vernon Lang, US Fish and Wildlife, 70 Commercial Street, Suite 300, Concord, NH 03301
Tim Timmerman, EPA-New England, Region 1, 1 Congress Street, Suite 1100, Boston, MA 02114-2023

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO
ATTENTION OF

RECEIVED
JUL 1 9 2004
PERKINS COIE LLP

Office of Counsel

July 14, 2004

Ms. Jena MacLean
Perkins Coie
607 14th Street NW
Washington, D.C. 20005

Re: Proposed Meeting To Discuss Legal Issues

Dear Ms. MacLean:

I am writing in response to your letter dated July 8, 2004, in which you requested a meeting with me to discuss legal issues relating to the Cape Wind project. While I appreciate your raising issues of concern regarding this project, I do not think a meeting to discuss the legal issues you raised would be productive, as I would not wish to risk waiving my clients' privileges by engaging in a conversation regarding the agency's position on legal issues. However, I would encourage you to submit any written comments that you deem appropriate, as you have done in the past.

Sincerely,

John P. Almeida

John Almeida
Assistant District Counsel

Conservation Law Foundation

Date: May 5, 2004

Mr. Patrick H. Wood, III, Chairman
Federal Energy Regulatory Commission
888 First Street NE
Washington DC 20426

Re: Regional Liquefied Natural Gas (LNG) Terminal Siting in New England

Dear Chairman Wood;

As you are aware, proposals for new Liquefied Natural Gas (LNG) terminals in New England and across the country have become extremely controversial. From my perspective as President of the Conservation Law Foundation (CLF), New England's largest regional environmental organization with offices throughout New England, it is apparent that LNG terminal siting is a regional issue of great importance and with significant environmental implications. CLF therefore proposes that the Federal Energy Regulatory Commission (FERC) work with the Governors of New England's coastal states and other federal officials to address the very complicated and controversial issues associated with LNG terminal siting through a New England region-wide approach.

CLF believes that New England's key regional policymakers need to engage in finding a solution to this issue, one that works for all New Englanders. After careful consideration, we believe that the solution lies in a regional evaluation of the merits of adding one or more new LNG terminals to New England's energy base and the development of a regional strategic plan for new terminal siting prior to approval of any individual terminal. This evaluation should include examination of opportunities at the state level to reduce overall energy demand through increased efficiency and to reduce demand for fossil fuels through increased use of renewable energies. CLF does not have the answers to these critical questions about terminal siting, but we ask you, as regional policymakers, to develop and evaluate the information needed to make fair and informed decisions about the need for additional terminal capacity in New England and the siting of such terminals. In the end, CLF's objective is to ensure that any new LNG terminal in New England is sited fairly, strategically, in an environmentally protective manner and on the basis of need.

To date, proposals for several potential LNG terminal sites have been advanced in New England, specifically in Maine, Massachusetts and Rhode Island. These proposals, however, are advancing on a community-by-community basis. As such, they are not part of a coherent strategy for evaluating the merits of one or more new terminal(s) for New England generally, or for any particular community specifically. From CLF's perspective, this *ad hoc* approach has not been effective and will continue to founder. It has pitted New England communities against one another in wrestling with the merits and the risks of specific proposals. This has led to very unproductive results.

Conservation Law Foundation

One issue that must be addressed is how much natural gas New England needs. There is tremendous variability in forecasts for New England's demand for natural gas. This is in part because many forecasts are made in support of specific agendas. Demand for natural gas in New England is partially driven by an environmental agenda: natural gas is an important transitional fuel until we move to a comprehensive renewable energy base. Simply put, more natural gas supply means lower prices; lower prices mean that cleaner-operating natural gas plants supply more of New England's energy demand. Indeed, significant air quality benefits would accrue if the natural gas power plants that now make up a substantial portion of the generating base of New England are fully utilized. New England's Independent System Operator forecasts that in 2005 roughly 45 percent of our regional electrical generating capacity will utilize natural gas. The Massachusetts Division of Energy Resources and the US DOE Energy Information Administration similarly forecast a steady rise in the percentage of New England's electricity coming from these plants.

Analysis by your staff estimates that peak monthly natural gas use can be met with the existing import capacity through 2005, and that proposed additions to import capacity would provide adequate capacity through 2010. But that analysis assumes that in addition to planned additions to pipeline capacity, some of which are in construction, by 2010 there will be (a) at least one new major LNG terminal built in Eastern Canada, (b) significant expansion of the existing LNG terminal in Boston Harbor and (c) at least one other new major LNG terminal, or two to three smaller LNG terminals with roughly the same capacity as a single large facility, in New England.

There are currently four announced LNG terminal proposals in New England and two in Eastern Canada. One proposed terminal for Harpswell, Maine was voted down by the community under very acrimonious circumstances on March 9 and now may be off the table. That result immediately focused attention on an undefined proposal to build an LNG terminal on Sears Island, in Penobscot Bay, Maine. Three other proposed terminals are clustered at the upper end of Narragansett Bay, Rhode Island. All three would require LNG tankers to travel up the main shipping channel of Narragansett Bay through the heart of Rhode Island waters. There is also an existing LNG terminal in Everett, Massachusetts and many people are concerned about possible future plans for expanding that facility.

New or expanded LNG terminals present significant potential environmental impacts. The risk of a catastrophic event would seem to argue against siting in urban areas such as those in Rhode Island and Massachusetts. While the extent of this risk is the subject of considerable debate, CLF believes that such a risk is, at a minimum, sufficiently credible to require a complete review as part of a regional approach to siting. On the other hand, there are numerous potential environmental impacts to the less populated coastal areas of Maine. One reason the Harpswell site was voted down was due to potential impacts on lobster fishing. Although Sears Island offers access to a deepwater port with suitable infrastructure, it is Maine's largest undeveloped island and the project may require considerable dredging. Sears Island is also located in the upper reaches of Penobscot Bay, a tremendous scenic and natural resource and some of the richest lobstering grounds in the world. More generally, there is also concern that LNG terminal siting, including potential off-shore sites, may provide additional infrastructure that will encourage exploration and development of potential off-shore oil and gas resources such as Georges Bank, long defended by CLF and others from such drilling.

Complicated issues such as these lead us to conclude that the best approach would be regional and strategic and address these issues proactively. There may be several tools that can serve as vehicles for such an approach. One tool that FERC could use would be the development of a programmatic environmental impact statement (EIS). The National Environmental Policy Act (NEPA) provides for the preparation of programmatic EISs in order to evaluate "broad actions" geographically (e.g., by region) or generically (e.g., common timing, impacts, alternatives), and anticipates that connected, cumulative or similar actions should be evaluated in a single EIS. 40 C.F.R. §§ 1502.4(b)(c); 1508.25(a)(1)-(3). The programmatic EIS can then be used to facilitate and expedite the preparation of subsequent project-specific EISs ("tiering"), allowing those documents to concentrate only on site-specific issues. 40 C.F.R. §§ 1500.4-5; 1502.4(d); 1502.20. Alternatively, a separate but equally rigorous regional alternatives study involving federal, state, and private participants could accomplish similar results, leaving the environmental impact analysis to FERC and the individual project proponent(s).

CLF believes that undertaking a regional approach to LNG terminal siting represents an important opportunity to address this controversial issue in a strategic manner and propel consideration beyond the current, site-specific, polarized siting debates. Most importantly to all of us, a more rational approach to LNG siting could help reduce New England's dependence on dirtier fuels like coal and oil while ensuring that the terminal site selection process provides an economically sensible and environmentally acceptable result.

In the coming weeks, my staff will contact your office to discuss FERC's interest in participating in initial meetings designed to advance a regional approach to LNG terminal siting. I appreciate your time and consideration of this proposal and look forward to working with your office to resolve this issue of utmost importance to New England. You or your staff may also contact me directly at 617-350-0990.

Sincerely yours,

Phillip Warburg, President
Conservation Law Foundation

CC Robert W. Varney, Regional Administrator, USEPA
Governor John E. Baldacci, State of Maine
Governor Craig Benson, State of New Hampshire
Governor Donald L. Carcieri, State of Rhode Island
Governor Mitt Romney, Commonwealth of Massachusetts
Governor John G. Rowland, State of Connecticut
Senator Edward M. Kennedy, Commonwealth of Massachusetts
Senator John F. Kerry, Commonwealth of Massachusetts
Senator Olympia J. Snowe, State of Maine
Senator Susan M. Collins, State of Maine
Senator Jack Reed, State of Rhode Island
Senator Lincoln D. Chafee, State of Rhode Island
Senator Judd Gregg, State of New Hampshire
Senator John E. Sununu, State of New Hampshire
Senator Christopher J. Dodd, State of Connecticut

Conservation Law Foundation

Senator Joseph I. Lieberman, State of Connecticut

Alliance to Protect
Nantucket Sound

396 Main St., Suite 2 Hyannis, MA 02601 508-775-9767
www.saveoursound.org

May 25, 2004

Colonel Brian A. Green
U.S. Army Corp of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Dear Colonel Green:

The Alliance to Protect Nantucket Sound has consistently argued that a programmatic and region-wide approach to the potential siting of offshore wind projects must be undertaken <u>before</u> the consideration of individual projects, such as the proposed Cape Wind project. The grounds for such an approach include all of the following:

- offshore wind projects "in New England and across the country have become extremely controversial";
- offshore wind project "siting is a regional issue of great importance and with significant environmental implications";
- offshore wind projects are "very complicated and controversial" and "the solution lies in a regional evaluation of the merits of adding one or more [offshore wind projects] to New England's energy base and the development of a regional strategic plan for [project] siting prior to approval of any individual [facility]";
- there is no "coherent strategy for evaluating the merits of one or more [projects] for New England generally, or for any particular community specifically";
- the current "<u>ad</u> <u>hoc</u> approach has not been effective and will continue to founder";
- "there may be several tools that can serve as vehicles for such an approach";
- the most appropriate vehicle for such a review is "the development of a programmatic environmental impact statement" under the National

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Environmental Policy Act, which is used to evaluate "broad actions geographically (e.g., by region) or generically (e.g., common timing, impacts alternatives), and anticipates that connected, cumulative or similar actions should be evaluated in a single EIS"; and

- such an approach, rather than project-specific, ad hoc analysis, such as is occurring now with great controversy, inefficiency, delay, and inadequate review, "can then be used to facilitate and expedite the preparation of subsequent project-specific EISs."

The Alliance first requested that the Corps adopt this approach by letter of April 1, 2004. The Safewind Coalition joined in this request in April, as well.

All of the above quotations, which the Alliance agrees with, come from a May 5, 2004 letter by the Conservation Law Foundation (CLF). Attachment 1. That letter is written to the Chairman of the Federal Energy Regulatory Commission regarding the potential development of Liquified Natural Gas terminals in New England. CLF's logic makes perfect sense, not only for LNG energy development, but also for offshore wind, and the Alliance again requests that the Corps suspend its environmentally unsound, unlawful, and conflict-inducing review of individual offshore wind projects such as the Cape Wind proposal in favor of the programmatic EIS approach advocated by CLF for region-wide energy development. The recent report of the U.S. Commission on Ocean Policy also calls for the use of a programmatic analysis of offshore wind energy development before individual projects are considered.

The need for such an approach is all the more evident now that a proposal has ripened for another major offshore wind project only 200 or so miles from the site of the proposed Cape Wind project. That project site on the southern coast of Long Island is, of course, a viable alternative to Nantucket Sound, as are many other locations considered and apparently ruled out by the Corps. Attachment 2. In fact, the Long Island site is closer to the Nantucket Sound site than some of the other alternatives that the Corps agreed to consider. There is no valid basis for precluding sites simply because they are not located in New England.

While the Alliance takes no position on the merits of the Long Island site, it is clear that the existence of such a project is further evidence of the need for a programmatic EIS. It also is an alternative that must be considered to the Nantucket Sound locations for the Cape Wind project. A programmatic EIS would clearly establish the basis upon which these and other sites could be considered, to use CLF's words, for purposes of developing a "regional strategic plan for siting prior to approval of any individual" project.

The Alliance again requests that the Corps adopt the legally-required, rational approach of undertaking a programmatic EIS of offshore wind before conducting any site-specific studies permit application reviews.

Very truly yours,

Susan Nickerson
Executive Director

Attachments

cc: See attached list

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CONSERVATION LAW FOUNDATION

June 10, 2004

Colonel Brian A. Green
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Re: May 25, 2004 Letter from the Alliance to Protect Nantucket Sound

Dear Colonel Green:

In a letter to you dated May 25, 2004, the Alliance to Protect Nantucket Sound (Alliance) urged the Corps to conduct a programmatic EIS and to suspend any further review of Cape Wind's proposal for a wind farm on Horseshoe Shoals in Nantucket Sound. Of particular concern to the Conservation Law Foundation (CLF) is that the Alliance's letter misleadingly invokes arguments advanced by CLF in favor of a regional strategic assessment of the need for additional Liquefied Natural Gas (LNG) terminals in New England. The purpose of this letter is to highlight the fundamental differences between CLF's proposal for a regional strategic plan for siting new LNG terminals and the Alliance's call for a moratorium and programmatic EIS on offshore wind development.

First, CLF's proposal for regional planning for LNG is premised on a fundamental data gap in the LNG context that simply does not exist for offshore wind. There is tremendous variability in forecasts for New England's demand for natural gas. As a result, we do not know how much gas is needed and how many new LNG facilities would be required to meet the region's demand for gas. Quite the opposite is true in the context of wind power. We know that large-scale renewable energy development is essential to meet Massachusetts's obligations under the Renewable Portfolio Standard (RPS) and to achieve the dramatic reductions in greenhouse gas emissions needed to minimize the threat of severe climate change. It is well-known that New England needs a number of small and medium-sized renewable energy projects on land *and* at least one project of the size, scale and scope of the proposed Cape Wind project in order to meet the RPS and climate change goals. We also know that wind is the most economically viable renewable energy source and that the Cape Wind project is presently the *only* proposal for a project of this size, scale, and scope in the region. The Alliance's suggestion that the Long Island wind project site "is an alternative that must be considered to the Nantucket Sound locations" ignores the fact that the Long Island project by its nature (i.e., because it is in New York and sponsored by a New York State public authority) cannot supply renewable energy that counts towards Massachusetts' RPS obligations.

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Second, fundamentally different motives underlie CLF's proposal for regional planning for LNG and the Alliance's call for a programmatic EIS on offshore wind development. CLF recognizes a need for increasing the region's supply of natural gas as a transition fuel while we work to expand our use of renewable energy resources, and has called for a regional strategic analysis to ensure that proposals for new LNG terminals are based on well-documented regional need. A programmatic EIS would be one option of many for conducting the regional assessment. The Alliance, on the other hand, has made very clear that its mission is to stop the Cape Wind proposal from becoming a reality, and has called for a programmatic EIS in an attempt to stall or prevent the project from moving forward. Indeed, the Alliance has explicitly asked the Corps to *suspend* further consideration of the Cape Wind proposal as part of a programmatic EIS. By contrast, in the LNG context, CLF has stated that a clear regional assessment should precede a *decision* on any individual sites, but has not suggested that relevant review processes for individual sites should be put on hold.

I hope that this letter resolves any confusion that may have resulted from the Alliance's correspondence of May 25, 2004. CLF continues to support rigorous and timely review of the Cape Wind proposal under Section 10 of the Rivers and Harbors Act and under the National Environmental Policy Act (NEPA). Please feel free to contact me should you have any questions or wish to discuss this further.

Very truly yours,

Philip Warburg

Philip Warburg
President

Cc: See attached distribution list

Conservation Law Foundation

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June 29, 2004

Lt. Col. Brian A. Green
U.S. Corps of Engineers
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Concord, Massachusetts 01742

Re: June 10, 2004 Letter From Conservation Law Foundation

Dear Colonel Green:

On May 25, 2004, I wrote to you on behalf of the Alliance to Protect Nantucket Sound to express our support for the position of the Conservation Law Foundation (CLF) that a programmatic environmental impact statement is necessary to review the potential for developing liquefied natural gas (LNG) facilities throughout New England. As stated in my letter, the Alliance strongly believes these same principles apply directly to the review of the Cape Wind project. Mr. Phillip Warburg, President of CLF, wrote to you on June 10, 2004, clarifying CLF's position. I am writing in response to his letter.

The Alliance strongly supports CLF's position regarding LNG facilities. We commend CLF for taking this position, and by copy of this letter to the Federal Regulatory Energy Commission, the Alliance urges the federal agencies involved in LNG facility review to adopt the CLF position. CLF has established an outstanding reputation over many years protecting the environment of New England. The Alliance looks forward to many years of working with CLF to protect the natural resource values of Nantucket Sound and to develop a comprehensive program for protecting the coastal and ocean areas of Massachusetts. Ad hoc decision-making on LNG facilities is a threat to the development of such a program, and we oppose the review of specific project proposals before an overall program to guide decision-making is created. As explained below, the same principles also apply to offshore wind.

In the June 10 letter, CLF explains why it holds the Cape Wind project to a different standard. As stated by Mr. Warburg, CLF's position derives principally from "Massachusetts' obligations under the renewable portfolio standard (RPS)." Mr. Warburg states that "[i]t is well known that New England needs a number of small and medium-sized renewable energy projects on land *and* at least one project of the size, scale and scope of the proposed Cape Wind project in order to meet the RPS and climate change goals." Thus, CLF is looking the Cape Wind project from the perspective of the RPS and alternative energy in New England. Further, CLF appears to have also made the internal policy determination that the Cape Wind proposal should be viewed only from the perspective of the need to bring online "at least one" large-scale wind energy project someplace in New England.

The Alliance takes a broader perspective. We believe that the issues presented by the Cape Wind proposal transcend the Massachusetts RPS. Indeed, because the Corps must make a decision on the Cape Wind project based upon the broad "public interest" test, advancing the Massachusetts RPS cannot be a limiting factor for the federal review. While CLF is free to base its position on the Cape Wind proposal on the project's relationship to the RPS, the Corps must define the scope of its action, and the alternatives considered, under much broader standards dictated by the overall public interest test.

The serious climate change problem does not, of course, lend itself to resolution on the local, or even regional, scale. To address this problem successfully, a coordinated effort is necessary on a widescale basis. Limiting potential solutions to a field as narrow as achieving the Massachusetts RPS or placing large-scale projects in New England, when more environmentally acceptable sites are readily available in other locations, is not the most effective way to proceed to address the global warming problem.

The broader perspective adopted by the Alliance on this issue also is repeated in the recent report from the U.S. Commission on Ocean Policy. The Commission recommends the use of a programmatic approach for reviewing offshore wind energy projects and acknowledges the need to establish new legal authorities that are specifically directed at this issue. The Commission determined that current law is inadequate for this purpose, a position the Alliance has taken from the outset of the Corps' review.

Finally, even under CLF's own definition of the need to meet the Massachusetts RPS, the approach being used for the Cape Wind project is invalid. The Corps is yielding improperly to the profit-making objectives of the permit applicant and following an approach that violates the National Environmental Policy Act by looking only at large-scale projects within New England. The limitation to New England has no rational basis. In addition, CLF states that "a number of small and medium size renewable energy projects" also will be needed to meet the Massachusetts RPS. If helping Massachusetts achieve its RPS standards is indeed a factor to be considered in the review of the Cape Wind project proposal, then the permit application review should also take into account those "small and medium size" projects both on land and offshore. The Corps has failed to undertake the necessary alternatives review, thereby compromising the environmental impact statement.

Thank you for considering these concerns. Please contact me if you have any questions regarding the Alliance's position.

Very truly yours,

/BS

Susan Nickerson
Executive Director
Alliance to Protect Nantucket Sound

cc: see attached list

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Maria Burks – Superintendent

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John Pagini
Nantucket Planning & Economic Development Commission

Colonel Michael W. Pratt
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Phillip Warburg
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UNITED STATES GOVERNMENT
MEMORANDUM

U.S. FISH AND WILDLIFE SERVICE

NEW ENGLAND FIELD OFFICE
70 COMMERCIAL STREET, SUITE 300
CONCORD, NEW HAMPSHIRE 03301-5087

TO: Karen Adams, Regulatory Division, NED December 11, 2002

FROM: Vernon Lang, Assistant Supervisor, NEFO

SUBJECT: Cape Wind Alternatives Screening Meeting

As requested at the November 25, 2002 meeting, I have reviewed the materials that were discussed and/or presented at the alternatives screening meeting including the presentations you emailed to the cooperating agencies.

My concerns remain essentially the same as those I expressed verbally at the meeting and in my November 13, 2002 Memorandum to you. I believe the alternatives screening process we discussed on November 25 is fundamentally flawed because as it is currently structured, it is essentially a strawman analysis to justify the applicant's proposals in Nantucket Sound. On one hand, the Corps is defining the project purpose to be a commercial scale renewable energy project providing power to the New England grid. On the other hand, the Corps is defining commercial scale to be within ± 20% of the applicant's 420 mw proposal and/or in the range of 200-1500 mw corresponding to recent ISO-NE projects. These definitions exclude fossil fuel and nuclear projects and all other renewable energy projects except a large scale wind facility or a theoretical tidal project. Working off these definitions, the applicant's consultant prepared an assessment of renewable technologies and concludes that each of them (solar, tidal, biomass, hydro and wave) except for wind are either infeasible (tidal); not feasible at a commercial scale (solar, wave); would require construction of numerous facilities to generate 420 mw and result in significant detrimental environmental impacts (biomass); or resources not sufficient in New England to provide 420 mw of new generation (hydro). Consequently, none of these technologies are carried forward in the EIS for further evaluation.

In the next screening step, the applicant's consultant prepared a fatal flaw matrix to screen potential wind energy sites. Some of the criteria are questionable as fatal flaw criteria. For example, a wind power classification of 4 or greater is used on the matrix while in Section 3.3.2.6.3 of the Renewable Technology Chapter, it says that a wind class 3 is needed to produce electricity from wind and that class 4 is preferred for utility-scale applications. Thus, it would seem that a wind class 3 should be the fatal flaw criterion, not wind class 4.

Sufficient excess transmission capacity to transport 200-1500 mw on the ISO-NE transmission system and sufficient land or water area to accommodate a 200-1500 mw wind energy project are not appropriate fatal flaw criteria for renewable energy projects. In my view, these are self-serving criteria designed to eliminate small- and medium-sized renewable energy projects from the list of reasonable alternatives. Once again, the fatal flaw criteria are contradicted by the Renewable Technology Chapter Section 3.3.2.6.2 where it states that wind installations range in size from 0.7-112.5 mw. This contradiction is further supported by the size of existing and proposed wind projects in the NE-NY area with the largest being in the 100 mw range exclusive of Cape Wind. In Vermont, recent proposals include projects with 5 (Little Equinox Mountain), 10 (East Haven Radar Base), 27 (Magic Mountain), and 30 turbines (Lowell Mountain). Recent proposals in upstate New York range in size from 11.5 mw (Madison County) to 100 mw (Lewis County). The Brodie Mountain Project in Massachusetts is, I believe, in the 13.5 mw range. Of course, you are aware of the 1- and 2-turbine projects in Hull and Princeton.

As I stated in my November 13 Memorandum and at the meeting, what constitutes a commercial-scale facility should be determined by the type of technology involved. A commercial-scale methane recapture project and other renewables, including those evaluated in the Renewable Technology Chapter, are at or below 1 mw in size. The transmission capacity to serve these commercial-scale facilities should be sized accordingly.

Under engineering and design limitations, I believe greater discussion is needed on the significant wave height criterion of <18 feet. As I recall, the Arklow Bank, Ireland, and an offshore facility in England are in unprotected ocean waters, and may be subject to wave heights >18 feet. I believe other unprotected open ocean sites are being developed off Denmark and Germany. Since much of this wind technology is of European design, it would be appropriate to understand the wave conditions they are designing projects to withstand. The Corps should independently verify the design limits of this technology in offshore environments.

I believe the AC transmission line criterion needs to be looked at more closely. As I recall at the meeting, the applicant used a 25-mile limit as measured from the land/ocean interface to the offshore facility as the maximum distance that an undersea AC cable could be operated feasibly. As I recall from the Winergy pre-application meeting, the shoal areas southeast of Nantucket Island are in the range of 7-15 miles offshore. This distance is well within the 25-mile criterion for Nantucket Island and perhaps as a direct cable connection to the Cape. In addition, as discussed at the meeting, either a buried or aerial cable could be used to cross Nantucket with a cable connecting the Island to the Cape. This would also seem to keep the AC cables under the 25-mile criterion. The last issue here deals with the dismissal of the DC transmission cable. I believe the Corps needs to independently verify the availability or lack thereof of underwater DC transmission cable technology for offshore energy facilities.

Renewable Technologies Chapter, Draft #2

As a general comment on this chapter, I detect a tendency to focus on the negative aspects of the renewable technologies except for wind power. I believe a more balanced discussion is needed to enable reviewers to understand the technology, where the technology is applicable, the capabilities of the technology, and the environmental benefits and impacts associated with its use. The end result should be to identify which of these energy technologies are reasonable alternative renewable energy technologies in the New England Region that require further evaluation in the Cape Wind EIS.

As I discussed at the meeting and in the screening section above, I do not believe these alternative technologies should be evaluated against the 420 mw ± proposal advocated by the applicant. To do so only makes a strawman analysis out of the alternatives analysis and invites criticism.

The applicant should confine the alternatives analysis to the New England geographical area for all technologies. The hydro analysis leaped into Northern Quebec and a discussion on impacts to native people. If the geographic range is expanded for one alternative, it should be expanded for all.

Specific Comments on Technology

Tidal - In Section 3.3.2.2.3, a statement is made that there are no viable sites in New England. In the late 1970s, the New England Division was conducting a feasibility study of tidal power in Cobscook Bay, Eastport, Maine. The paragraph should be modified to be consistent with the second paragraph in this Section.

In addition to traditional tidal power projects, a new generation of tidal-powered turbines is under development. At least one in Maine and one in Massachusetts have been proposed/installed using a helical turbine design. These are also known as the Gorlov helical turbine.

Biomass - It was not clear whether the applicant was including methane recapture projects at landfills and methane generation projects using manure under the broad category of biomass projects. These technologies should be evaluated since we have these projects in New England.

I believe the Corps needs to independently verify whether biomass gasification and/or combined cycle technology for any biomass fuel is commercially available. This could have a bearing on the acceptability of some of this technology from an air quality perspective.

Questions may be directed to me at 603-223-2541 or email vernon_lang@fws.gov.

December 19, 2002

Ms. Karen Kirk Adams
U.S. Army Corps of Engineers
New England Division
696 Virginia Road
Concord, MA 01742-2751

RE: Comments on Alternatives/Screening criteria & Visual Assessment

Dear Ms Adams:

This letter is intended to supplement our comments of December 9, 2002 on the draft screening criteria and alternative sites proposed for the Cape Wind Project. These additional comments are generated in response to information presented at the latest Massachusetts Technology Collaborative (MTC) Stakeholders meeting held on December 12, 2002.

Visual Impact Assessments

We hope that the Corps is intending to embark on a full visual impact assessment that goes beyond the photo-simulations presented to date and includes a study similar to the 8-step process outlined in the presentation given on behalf of Dr. R.C. Smardon at the December 12, 2002 MTC meeting. Dr Smardon's framework for analysis uses photo-simulations in conjunction with a number of other factors, including coastal characteristics and viewer sensitivity, to establish the visual impacts of a project. This methodology is appropriate in the context of the review of this project.

Regarding the photosimulations themselves, we believe that the Corps should establish set times for the photographs to be taken for each location, to allow a consistent comparison between sites. For instance, the visual simulations presented at the MTC Stakeholders meeting on December 12, 2002, showed similarities between the simulations of the proponents and opponents in terms of the turbines size and scale. However, although the photographs were taken in the same general location, differences in the time of day, season and elevation of the photographs accounted for a marked difference in the apparent visibility of the project. It would therefore seem appropriate to establish set times of day for a series of photographs to be taken for each location (e.g photos every 4 hours). This would show the project in a range of lighting conditions (i.e.

front lit and back lit) and environmental conditions (i.e. diffused light, bright sun etc.) and would meet the purpose of NEPA in providing objective information for decision-makers. The Corps should also require that photo-simulations account for changes in season, when the angle of the sun may affect the visibility of the towers.

Perhaps more importantly, the photo-simulations currently presented are limited in that they present a static view of a moving project. This is problematic given the lack of comparable projects that illustrate what 170 moving objects in the marine environment will look like. The Commission staff would suggest that an animated visual assessment would provide a clearer picture of the eventual appearance of such a facility. For example, an animation was prepared for the Middelgrunden wind farm in Denmark that places a moving, simulated turbine into a static photograph. [Two animated simulations can be downloaded and viewed at http://www.middelgrunden.dk/MG_UK/project_info/visualization.htm]. Similar animations could be employed in a limited number of locations to help inform participants in the process and also used to compare the different visual impacts of alternative turbine configurations.

Alternatives & screening criteria

Our letter dated December 6, 2002, we recommended that the Corps include alternative turbine configurations as part of the DEIS in accordance with the NEPA guidelines contained in 33 CFR Part 325, Appendix B, Section 9(b), 5(c). This seems particularly relevant in light of the information provided on the Middelgrunden wind farm at the MTC meeting. The Middelgrunden turbines are spaced 183 meters (600 feet) apart, considerably closer than the half to one third mile (2,638 – 1,758 feet) separation of the Cape Wind turbines. Although the spacing of the Cape Wind turbines is partly to allow the use of the interstitial area by boats, it would be valuable for the DEIS to consider what a tighter arrangement of turbines would look like. Presumably, an arrangement of turbines of the same capacity as Cape Winds project where the spacing is minimized would result in the wind farm occupying a far smaller area and present a much reduced visual impact. Conversely, tighter spacing between turbines might also allow far greater numbers of turbines to occupy the same area as Cape Wind's current proposal, and presumably provide significantly larger amounts of electricity than the current 420 MW capacity. Although these options may not be preferable for the applicant, they would allow the relative merits of the applicants project and each alternative to be gauged, in accordance with the requirements of NEPA.

Earlier drafts of the preliminary alternative sites had listed more urban areas as sites for consideration, particularly the offshore areas in the vicinity of Boston Harbor and New Bedford. Our recollection is that these were dismissed as they may be hazardous to navigation. However, the video presentation of the Middelgrunden project clearly showed large vessels sailing very close to the turbines. The commentary noted that there was little concern about collision as the shallow water in the vicinity meant that ships would run aground before hitting the turbines. Presumably, this same rationale could be applied to offshore locations in and around Boston and New Bedford, and therefore we believe that these alternative sites should remain on the preliminary list for the DEIS.

Finally, we would refer to the presentation given by Mr. Bruce Bailey describing the Long Island Power Authority's alternatives study, that used a commercially viable capacity of 100MW as their preliminary screening criteria. This size is in sharp contrast to the current 200 to 1,500 MW capacity of the preliminary screening criteria used for the DEIS on Cape Wind's project. Mr. Bailey's presentation reinforced our belief that the capacity range needs to be tailored to renewable energy generators rather than the range typical of connections to the ISO-New England grid to date. This point is discussed more fully in our December 9, 2002 letter.

I hope that these additional comments are helpful to the Corps as you develop the DEIS, thank you again for the opportunity to comment.

Sincerely,

Margo Fenn,
Executive Director,
Cape Cod Commission

cc: Cape Cod Commission Subcommittee Members (Aitchison, Ansel, Broidrick, Deane, Kadar, Taylor, Virgilio)
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RECEIVED OCT 14 2003 ...Y DIVISION

October 9, 2003

Ms. Karen Adams
U.S. Army Corps of Engineers
New England Division
696 Virginia Road
Concord, MA 01742-2751

RE: EIS Alternatives

Dear Ms Adams:

Thank you for the opportunity to participate in the inter-agency meeting at your offices on September 24, 2003 to discuss the alternatives and screening criteria for the Cape Wind Environmental Impact Statement (EIS). The following comments are those of the Commission staff as the Commission subcommittee has not reviewed the materials distributed at the September 24th meeting regarding the Corps approach to the EIS alternatives analysis, and in regard to the draft Peer Review comments and EIS appendices. The Commission staff continues to look forward to assisting the Corps in developing a thorough and objective EIS for this project.

Meeting Notes

We have received the draft notes of the September 24, 2003 meeting and in general believe they reflect the gist of much of the discussion. At the meeting, agencies represented were asked to comment on whether the sites under consideration were appropriate or could be excluded from further analysis. Commission staff at the meeting felt uncomfortable with commenting on many of these sites, particularly as the exact locus was undefined and that the participants had no opportunity to conduct their own assessment of the constraints for each site. There was also some disagreement on whether some of the identified constraints were accurate. For example, some questioned whether navigation issues for shipping at New Bedford would eliminate that site from consideration. Speaking for the Commission staff only, the fact that few comments were offered for individual sites at the meeting was more a reflection of a lack of information than a signal of agreement. Therefore, we would suggest that where it is indicated that there was a consensus or agreement, it should be clear that there was only partial agreement among the participants.

Alternative Sites/Flexible application of Screening Criteria

The Commission staff support the Corps recent more flexible application of the screening criteria for the alternatives analysis portion of the DEIS, rather than the pass/fail application previously proposed. In addition, we believe that the analysis of representative alternatives has merit for such a complex project and that as a broad concept, this approach is worth pursuing. In principal at least, this approach would seem to allow for a broader range of alternatives (and their relative impacts) to be evaluated in the DEIS. However, Commission staff have some concerns over the steps taken to arrive at the representative sites.

We are concerned that the list of alternatives has not been developed by any methodical analysis of viable wind sites in New England. Instead, the sites under consideration have been accumulated via suggestions made at meetings based on independent knowledge. While this has certainly identified potential sites, the methodology could be open to criticism in that it does not objectively look at the region as a whole. We recognize the difficulty in evaluating a large, geographical area such as New England, however, it seems that such an exercise is vital in order for the EIS Alternative Analysis to be supportable. An approach that would potentially address this concern was suggested by the Peer Review group: "What would be helpful would be some analysis showing areas in New England with the required wind speed, the amount of land required, and the cost of transmission upgrades needed for grid access." This would clearly provide an objective base for the start of the analysis, from which the screening criteria could be applied.

Additional Suggestions

We are encouraged by the consideration of multiple sites as an alternative to a single, large facility. We strongly believe that distributed facilities have many benefits, not the least of which is the potential for easier integration into the transmission system and potentially lesser environmental impacts. However, as we have commented in earlier correspondence, we don't believe that close geographical proximity is necessarily an appropriate factor when considering multiple sites, although it may affect the economic return on the project. Therefore, we would suggest that this constraint be reconsidered.

Based on the discussions at the September 24th meeting and the meeting we attended in Boston on September 29 and 30 sponsored by the Dept of Energy, it seems that a potential combination of sites worth considering would be a combination of Boston Harbor and New Bedford. The National Park Service has already begun a process of evaluating wind turbines in the Boston Harbor Islands Recreation Area and the Town of Hull is considering placing additional turbines offshore in the vicinity. It also appeared from the US Coast Guard that there would be room for turbines outside the navigational channels of New Bedford. This combination of smaller deployments would provide a more urban setting for offshore facilities and may in combination reach the lower end of the range of facilities.

Furthermore, as we have suggested in prior correspondence, we believe the following alternatives should also be considered:

- Smaller facilities (i.e. fewer turbines) at Horseshoe Shoals
- Alternative design configurations that may have less visual impact. For instance, the Middlegrunden facility was redesigned to be more visually pleasing. It would be useful to have an analysis of different sized turbines, particularly in locations closest to shore, that would potentially have less visual impact and keep the capacity within the range under consideration.

- An analysis of whether choosing the largest machines available makes the most efficient use of the wind resource, at least as weighed against the watersheet area occupied, prevailing versus average wind conditions, turbine spacing, rotor diameter and visual impacts. For example, could a smaller turbine or rotor that operates at lower wind speeds produce sufficient energy to make a project viable and have less visual impacts and occupy less area of the Sound? Cape Wind is proposing to use the largest turbine currently available to maximize return on investment. The EIS should provide an assessment of whether this approach is in the public interest.

Peer Review Summary

With reference to the Draft EIS conclusions on alternatives, the Peer Review Summary notes that "there are many cases where the logic used to reach these conclusions is either flawed or is stretching reality" and that it "has the appearance of being written by advocates for the project rather than the USACE". The aim of the EIS is to provide unbiased and objective information, and as such, even the appearance of a conflict or subjectivity can severely undermine the integrity of the process. It is currently unclear to what extent the Peer Reviewers comments will be embraced, but our hope is that the Corps is able to remedy the situation by presenting a balanced view of the complex information available.

This comment could also be made in relation to the application of the screening criteria, and the Commission staff would suggest that the Corps make every effort to consistently apply the selected criteria. For instance, navigational issues and proximity to shipping lanes and flight paths are raised as constraints for a number of offshore sites, although they are not listed under the screening criteria and no description of what constitutes a conflict is included. In contrast, Table 3-6 which deals with the three Nantucket Sound sites, repeatedly references "minimal conflicts" with shipping and aviation for those sites, but provides no discussion of what constitutes a minimal conflict. At face value, it seems that this criterion has not been evenly applied and it would therefore be appropriate to expand on how the criteria are applied and the parameters of each.

As a number of independent sources have confirmed, including the Peer Reviewers, the relevance of these criteria depends on many factors. By some estimates an offshore project could be viable with as little as 100MW (or less) capacity. As the Commission pointed out in our December 19, 2003 letter, this figure is in sharp contrast to Cape Wind's capacity and the range of projects under consideration in the EIS (200MW-1,500MW). It is perhaps more appropriate for the range of facilities under consideration to be based on what is economically feasible for renewable facilities, rather than what has historically been connected to ISO-New England's grid. We have continually commented that the range currently being used is inappropriate to the project purpose and need. This concern seems to be shared by the Peer Reviewers who felt "that there are "utility scale" wind projects less than 200MW" and that "Many wind power plants with capacities under 100MW are installed in the US". We strongly recommend that the Corps reconsider whether this range is appropriate.

The size of the project has a direct bearing on the application of a number of the screening criteria, most notably the transmission surplus and land/watersheet area needed. At the September 24^{th} meeting, many sites were shown to have insufficient capacity or available area to accommodate the range established (200-1,500 MW). However, this analysis would be different if a smaller area was needed and if a smaller surplus in the transmission capacity was applied. As mentioned in the Peer Review Summary, there are also some rules of thumb applied to this analysis (particularly regarding turbine spacing, rotor diameter and available area) that may be flawed which would further affect the viability of alternative sites. Therefore it seems that elimination of some sites at this stage may be premature, given the comments made by the Peer Review group.

A common thread that runs throughout the Peer Review summary refers to the economic considerations in developing this kind of project. These factors have a direct bearing on the applicability of the screening criteria. For instance, the economic viability of a project is as much related to the financier's return on investment, as it is to wind speed, water depth, land/water area and distance from shore, etc. Therefore, the EIS should also include a broad and generalized economic feasibility analysis for an offshore wind farm that is not specific to Cape Wind to provide an insight into these issues. This should include a detailed discussion of how the price paid for energy and "green attributes" affect the economic viability of a project and how wind resource relates to this analysis.

The Peer Review summary also raises a significant issue related to the long-term viability of the project and that should the project fail, it would be "the worst possible environmental outcome." It seems that this would also be the worst possible outcome for the emerging offshore wind energy industry, renewable energy advocates in general and for the users and neighbors of Nantucket Sound. This concern is shared by many and should be addressed in the EIS for this experimental technology. A "failed, bankrupt project" at the location selected by Cape Wind is likely to set renewable wind energy development back for decades and thus it is imperative that provision be made to address this issue. For instance, a phased installation would provide some degree of testing for the technology and would be consistent with the precautionary approach to emerging technologies. Similarly, although bonding for removal/decommissioning is traditionally a mechanism for dealing with abandoned facilities, it seems unlikely that Cape Wind would be willing to provide a bond sufficient to ensure complete site restoration.

We hope that the Corps will give careful consideration to the comments made by the Peer Review group as the Draft EIS is prepared, thank you for the opportunity to comment.

Sincerely,

Margo Fenn,
Executive Director,
Cape Cod Commission

cc: Cape Cod Commission Subcommittee Members (Aitchison, Ansel, Broidrick, Kadar, Taylor, Virgilio)
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Boston Business Journal - October 25, 2004
http://boston.bizjournals.com/boston/stories/2004/10/25/story1.html

Boston Business Journal

EXCLUSIVE REPORTS

From the October 22, 2004 print edition

New Mass. wind plans aloft

As controversy swirls over Cape Wind, some look beyond horizon

Alexander Soule
Journal Staff

As the Army Corps of Engineers finalizes a massive environmental report on wind-power turbines off Nantucket, Massachusetts policymakers are crank-starting a plan to site turbines in the deeper reaches of the Atlantic Ocean.

Last week, the nascent Offshore Wind Energy Consortium hired a Washington, D.C.-based consulting firm called Resolve Inc. to produce a feasibility study by January.

The project currently has a budget of $700,000 underwritten by General Electric Co., the Massachusetts Technology Collaborative and the U.S. Department of Energy.

The Offshore Wind Energy Consortium (OWEC) is initially considering the use of either floating platforms anchored to the ocean floor or, more likely, stilts set in up to 100 feet of water. But other possibilities could emerge as well.

Near-shore projects, such as the one promoted by Cape Wind Associates off Nantucket, have been limited to shallower waters with depths of up to 50 feet.

"Is this goal reasonable and realistic? We (want to) get the people to the table who will ask the thorniest questions," said Greg Watson, an MTC official who is spearheading OWEC. "The feedback we have gotten is right on -- this is doable, and it is something we should do."

But it could take until the end of the decade to pull it off, he said, as the consortium faces an array of engineering, environmental, climatic, regulatory and financial challenges.

Niskayuna, N.Y.-based GE Global Research originally approached MTC about the project 18 months ago. In January, 13 organizations attended an informational meeting in Boston. In August, MTC issued invitations for consulting firms to bid on the project.

OWEC's general goal is to produce plentiful supplies of electricity at 5 cents per kilowatt hour or less -- a price that would put it on a competitive stance with natural gas, but still about 2 cents per kilowatt hour more expensive than traditionally generated power.

But the organization also envisions building a cluster of Massachusetts businesses supporting wind farms across the globe. They might manufacture turbines, cabling, sensors and towers. Or they might mind the wind farms themselves, performing ocean surveying, construction, maintenance and ecological monitoring.

In a 67-page report issued last week, Washington, D.C.-based policy think tank Renewable Energy Policy

Project said some 90 companies in 25 states currently manufacture components of wind turbine systems. While the wind power industry could create more than 3,000 new jobs in Massachusetts, REPP estimated, Massachusetts only barely cracked the top 20 among states nationally, trailing far behind California, Ohio and Texas.

Somerville-based Second Wind Inc., which produces sensors for use in wind farms and employs 25 people, was the only Massachusetts company listed by REPP with expertise in the sector. Northern Power Systems Inc. in Waitesville, Vt., produces wind turbines, and a pair of Rhode Island companies make rotor blades and turbine housings.

The report may have missed at least one other player: A system from Westborough-based American Superconductor Inc. is used in Scotland's Orkney Islands to deal with power fluctuations produced by wind farms off the coast there.

The limited commercial manpower did not deter GE Global Research from exploring the feasibility of a wind farm off the Massachusetts coast, Watson said. The state has a Renewable Energy Trust Fund to help support the project, and GE recognized that policymakers here are getting their regulatory sea legs as the Nantucket wind farm proposal, being promoted by Boston-based Cape Wind Associates, goes through its contortions.

GE was also drawn by the presence in Massachusetts of other organizations with experience in wind power research. The Massachusetts Institute of Technology, the University of Massachusetts and Woods Hole Oceanographic Institute are earmarked to receive research funding from OWEC.

Europe is far ahead of the United States in wind power companies, Watson said. But he said Europe's topography, with abundant shoals that stretch far out of sight of land, has not encouraged the development of deep-water power generation techniques.

"What we have discovered as a result of the permitting process around Cape Wind is there are not that many shallow water sites that are developable," Watson said. At 50 feet, "that pushes the limit of these things -- as the waves bash against towers, there is a constant shaking and vibration. We can make (towers) sturdier, but that adds to the cost. Deep water (wind power generation) will not be about taking on-shore technology, sealing it up, and moving it off-shore. It will mean developing whole new technologies."

Denmark, the only other country to undergo the 1973 Arab oil embargo, leads the European wind power industry today with some 20,000 workers, said James Gordon, president of Cape Wind.

Gordon termed OWEC's timeline "pretty optimistic" for producing deep-water wind power by the end of the decade and said that Cape Wind must succeed in order to provide a training laboratory for future U.S. wind power engineers and executives.

"We think we can make Massachusetts a worldwide leader in wind power generation," Gordon said. "But how the heck (is OWEC) going to be able to do that without the experience we would bring?"

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Exhibit TAH-1

Department of Energy 906 Data

Power Supplier	Facility Name	State	Fuel	Source	Average Capacity MW	Capacity MW 2000	2001	2002	2003	Generation (GWh) 2000	2001	2002	2003	Capacity Factor % 2000	2001	2002	2003
Kotzebue Elec Assn Inc	Kotzebue	AK	Wind	759A	0.66		0.7		-		950	-	-		16%		
Altamont-Midway Ltd	Altamont Midway Limited	CA	Wind	906N	10.92		10.9	10.9	10.0	-	18,972	17,316	14,293		20%	18%	16.3%
Cabazon Wind Partners LLC	Cabazon Wind Partners	CA	Wind	906N	40.92			-	30.8			-	87,697				32.5%
CalWind Resources Inc	Tehachapi Wind Resource I	CA	Wind	906N	9.00			-	8.3		-	-	14,421				19.9%
CalWind Resources Inc	Tehachapi Wind Resource II	CA	Wind	906N	21.80		21.8	21.8	20.0	-	23,982	40,488	47,709		13%	21%	27.2%
Cameron Ridge LLC	Cameron Ridge	CA	Wind	906N	57.00	57.0	57.0	57.0	57.0	180,941	168,686	181,520	172,350	36%	34%	36%	34.5%
Difwind Farms Ltd V	Difwind Farms Limited V	CA	Wind	906N	11.77		11.8	9.8	10.8	-	22,733	21,134	17,823		22%	25%	18.9%
Difwind Farms Ltd VI	Difwind Farms Limited VI	CA	Wind	906N	27.11		27.1	13.4	24.9	-	50,255	16,704	48,194		21%	14%	22.1%
Difwind Farms Ltd VII	Difwind Farms Limited VII	CA	Wind	906N	24.00		24.0	24.0	22.0	-	54,725	49,301	41,886		26%	23%	21.8%
Difwind Farms Ltd VIII	Difwind Farms Limited VIII	CA	Wind	906N	15.00		15.0	15.0	13.7	-	22,984	25,919	21,586		17%	20%	18.0%
Enron	Green Power I	CA	Wind	906N	16.50		16.5	8.2	2.8	-	49,337	20,820	4,486		34%	29%	18.6%
ESI Mojave LLC	Mojave 16	CA	Wind	906N	30.00		30.0	30.0	30.0	-	52,746	62,491	53,456		20%	24%	20.3%
ESI Mojave LLC	Mojave 17	CA	Wind	906N	25.00		25.0	25.0	25.0	-	49,621	51,841	45,731		23%	24%	20.9%
ESI Mojave LLC	Mojave 18	CA	Wind	906N	30.00		30.0	30.0	30.0	-	48,883	65,770	65,478		19%	25%	24.9%
EUI Management PH Inc	EUIPH Wind Farm	CA	Wind	906N	25.54		25.5	25.5	14.8	-	49,997	54,604	22,584		22%	24%	17.4%
Flowind Corp	Altamont Power LLC	CA	Wind	906N	28.70		28.7	28.7	28.7	-	9,693	6,371	3,524		4%	3%	1.4%
FPL Energy	High Winds LLC	CA	Wind	906N	145.80			-	61.1			-	155,588				29.1%
FPL Energy	South Dakota Wind Energy Center	CA	Wind	906N	40.00			-	6.7			-	29,284				50.0%
Green Ridge Service LLC	Montezuma Hills Windplant	CA	Wind	906N	60.00	60.0	60.0	50.0	9.7	96,072	92,224	96,332	3,211	18%	18%	22%	3.8%
Green Ridge Services LLC	San Gorgonio Windplant	CA	Wind	906N	3.00			1.5	-	-	-	1,576	-			12%	
Howden Wind Parks Inc	Howden Windpark I	CA	Wind	906N	24.75		24.8	24.8	24.8	-	36,053	32,720	26,543		17%	15%	12.2%
International Turbine Res Inc	Dinosaur Point	CA	Wind	906N	17.44		17.4	17.4	17.4	-	23,461	27,997	23,796		15%	18%	15.6%
Kenetech Windpower Inc	Altamont Pass Windplant	CA	Wind	906N	312.80	312.8	312.8	312.8	259.7	462,335	652,988	282,610	607,359	17%	24%	10%	26.7%
Northwind Energy Inc	Northwind Energy Incorporated	CA	Wind	906N	13.08		13.1	11.9	12.0	-	19,637	16,611	15,940		17%	16%	15.2%
Oak Creek Energy System Inc II	Oak Creek Energy Systems Incorporat	CA	Wind	906N	27.90		27.9	27.9	25.5	-	77,530	103,741	82,278		32%	42%	36.8%
Pacific West I	Pacific West	CA	Wind	906N	2.10		2.1	2.1	2.1	-	7,410	8,032	8,032		40%	44%	43.7%
PGE Energy	Mountain View I	CA	Wind	906N	44.40			33.5	44.4	-	-	134,252	129,203			46%	33.2%
PGE Energy	Mountain View II	CA	Wind	906N	22.20			-	22.2	-	-	67,774	62,864				32.3%
Ridgetop Energy LLC	Cannon Energy Corp	CA	Wind	906N	60.43	60.4	60.4	60.4	60.4	200,079	154,224	164,003	166,102	38%	29%	31%	31.4%
Ridgetop Energy LLC II	Carwest Partners I	CA	Wind	906N	13.00	13.0	13.0	13.0	13.0	42,899	36,901	39,057	39,764	38%	32%	34%	34.9%
Sacramento Mun Util Dist	Solano	CA	Wind	906U	16.70	6.8	6.8	16.6	16.7	6,774	7,136	4,310	26,919	11%	12%	3%	18.4%
San Gorgonio Wind Farms Inc	San Gorgonio Farms Wind Energy Pow	CA	Wind	906N	33.74		33.7	33.7	33.7	-	104,629	96,541	82,184		35%	33%	27.8%
Seawest Windpower Inc	Altech III	CA	Wind	906N	32.39		32.4	32.4	29.6	-	31,522	57,994	38,247		11%	20%	14.7%
Seawest Windpower Inc	San Gorgonio Westwinds II LLC	CA	Wind	906N	43.40			-	39.7	-			103,893				29.9%
Southern Calif Sunbelt Devel	Edom Hill	CA	Wind	906N	11.02		11.0	11.0	7.3	-	14,851	17,462	4,182		15%	18%	6.5%
Tomen Power Corp	Viking Windfarm II	CA	Wind	906N	14.56		14.6	14.6	2.4	-	73,784	81,158	7,823		58%	64%	37.9%
TPC 3/5 Inc	Mojave 3	CA	Wind	906N	23.50		23.5	23.5	23.5	-	70,807	74,088	66,135		34%	36%	32.1%
TPC 3/5 Inc	Mojave 5	CA	Wind	906N	22.50		22.5	22.5	22.5	-	67,751	68,844	66,734		34%	35%	33.9%
TPC 4 Inc	Mojave 4	CA	Wind	906N	29.00		29.0	29.0	29.0	-	84,317	86,924	75,171		33%	34%	29.6%
TPC Windfarms LLC	TPC Windfarms LLC	CA	Wind	906N	29.00			-	21.9	-	-	-	67,585				35.2%
Victory Garden Phase IV Part	Victory Garden Phase IV Partnership	CA	Wind	906N	22.05		22.1	9.1	16.6	-	40,282	22,080	36,479		21%	28%	25.2%
VMSO IV Corp	Cabazon Wind Farm	CA	Wind	906N	39.75		39.8	33.1	10.0	-	103,585	99,742	17,613		30%	34%	20.1%
Westwind Trust	Westwind Trust	CA	Wind	906N	16.04		16.0	16.0	14.7	-	29,360	34,337	24,173		21%	24%	18.7%
Whitewater Hill Wind Parnters	Whitewater Hill Wind Partners	CA	Wind	906N	61.50			-	46.3			-	134,256				33.1%
Windland Inc	Windland, Incorporated	CA	Wind	906N	16.00		16.0	14.6	16.0	-	22,707	26,615	28,318		16%	21%	20.2%
Windpower Partners 1993 LP	San Gorgonio Windplant WPP93	CA	Wind	906N	34.50		34.5	34.5	34.5	-	104,230	134,342	106,206		34%	44%	35.1%
Wintec Energy Ltd	Wintec Energy Ltd	CA	Wind	906N	16.20		16.2	14.8	16.2	-	49,851	47,485	39,756		35%	37%	28.0%
Zond Systems Inc	Victory Garden	CA	Wind	906N	28.62		28.6	28.6	4.8	-	29,815	27,495	3,713		12%	11%	8.9%
Zond Systems Inc	Painted Hills Wind Developers	CA	Wind	906N	19.19		19.2	19.2	3.2	-	34,144	36,906	3,480		20%	22%	12.4%
Zond Systems Inc	Santa Clara	CA	Wind	906N	18.00		18.0	18.0	3.0	-	30,354	33,495	982		19%	21%	3.7%
Zond Systems Inc	Mesa Wind Developers (ZPI)	CA	Wind	906N	19.50		19.5	19.5	3.3	-	41,576	44,923	6,555		24%	26%	23.0%
Zond Systems Inc	Sky River Partnership	CA	Wind	906N	76.95	77.0	77.0	77.0	57.8	237,974	201,280	210,750	161,164	35%	30%	31%	31.8%
Zond Systems Inc	251 Project	CA	Wind	906N	19.41		19.4	19.4	19.4	-	38,123	40,613	41,185		22%	24%	24.2%
Zond Systems Inc	33 East 85-A	CA	Wind	906N	14.92		14.9	14.9	14.9	-	19,458	20,472	20,424		15%	16%	15.6%
Zond Systems Inc	33 East 85-B	CA	Wind	906N	21.60		21.6	21.6	21.6	-	27,425	30,174	30,347		14%	16%	16.0%
Zond Systems Inc	Mesa Wind Developers (ZPII)	CA	Wind	906N	10.40		10.4	10.4	10.4	-	22,759	24,667	25,873		25%	27%	28.4%
Zond Systems Inc	Helzel and Schwarzhoff	CA	Wind	906N	1.80			-	0.3	-	-	-	468				17.8%
Zond Systems Inc	K-Site	CA	Wind	906N	6.38			-	1.1	-	-	-	877				9.4%
Public Service Co of Colo	Ponnequin	CO	Wind	906U	30.00			30.0	30.0		-	59,987	58,477			23%	22.3%
Ridgecrest Wind Partners, LLC	Peetz Table Wind Farm	CO	Wind	906N	29.70			29.7	29.7	-	-	77,361	77,109			30%	29.6%
Hawaii Electric Light Co	Lalamilo	HI	Wind	906U	1.56	1.6	1.6	1.6	1.6	2,649	2,110	1,605	1,562	19%	15%	12%	11.4%
Cedar Falls Utilities	IDWGP	IA	Wind	906U	2.25			2.3	2.3	-	-	6,901	5,633			35%	28.6%
FPL Energy Hancock County Wind	Hancock County	IA	Wind	906N	98.00			-	98.0			-	237,530				27.7%
Hawkeye Power Partners LLC	Hawkeye Power Partners LLC	IA	Wind	906N	42.00			38.4	42.0	-	-	90,804	118,438			27%	32.2%
Northern Iowa Windpower, LLC	Top of Iowa	IA	Wind	906N	80.10			80.1	80.1	-	-	168,992	93,929			24%	13.4%
Waverly (City Of)	Skeets 1	IA	Wind	906U	0.08	0.1	0.1	0.1	-	160	185	214	-	23%	26%	31%	
Waverly (City Of)	Northwest	IA	Wind	906U	1.50	1.5	1.5	1.5	-	3,224	3,867	4,375	-	24%	29%	33%	
FPL Energy	Gray County Wind Energy	KS	Wind	906N	112.00			93.9	112.0	-	-	321,539	364,288			39%	37.1%
Traverse City Power & Light	TCLP	MI	Wind	Utility	0.60	0.6	0.6	-	-	754	858			14%	16%		
Dairyland Power Cooperative	G McNeilus Wind	MN	Wind	906N	17.00			-	4.3			-	32,713				87.2%
Enron Wind Dev Corp LB I	Lake Benton 1 Wind Power Facility	MN	Wind	906N	107.25	107.3	107.3	98.1	107.3	274,060	304,581	283,543	280,857	29%	32%	33%	29.9%
Enron Wind Dev Corp LB II	Lake Benton II Wind PO Facility	MN	Wind	906N	103.50	103.5	103.5	95.0	103.5	296,103	334,936	286,343	325,830	33%	37%	34%	35.9%

Exhibit TAH-1

Department of Energy 906 Data

Power Supplier	Facility Name	State	Fuel	Source	Average Capacity MW	Capacity MW 2000	2001	2002	2003	Generation (GWh) 2000	2001	2002	2003	Capacity Factor % 2000	2001	2002	2003
Enron Wind Dev Corp SL I	Storm Lake 1 Wind Power	MN	Wind	906N	112.50	112.5	112.5	112.5	66.0	287,270	281,969	309,353	153,696	29%	29%	31%	26.6%
Enron Wind Dev Crop SL II	Storm Lake II Wind PO Facility	MN	Wind	906N	80.25	80.3	80.3	80.3	80.3	209,149	195,482	229,634	192,459	29%	28%	33%	27.4%
Northern Alternative Energy	Lakota Ridge	MN	Wind	906N	11.25		11.3	11.3	10.3	-	30,482	33,030	28,277		31%	34%	31.4%
Northern Alternative Energy	Shakokatan Hills	MN	Wind	906N	11.88		11.9	11.9	10.9	-	37,079	41,023	33,855		36%	39%	35.6%
Northern Alternative Energy	Tsar Nicholas LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,766	6,458	5,921		16%	37%	34.1%
Northern Alternative Energy	Sun River LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,588	6,295	5,872		15%	36%	33.9%
Northern Alternative Energy	Julia Hills LLC	MN	Wind	906N	1.98		2.0	1.8	2.0	-	2,760	5,948	5,765		16%	37%	33.2%
Northern Alternative Energy	Jessica Mills LLC	MN	Wind	906N	1.98		2.0	1.8	2.0	-	2,566	5,714	5,842		15%	36%	33.7%
Northern Alternative Energy	Jack River LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,641	6,170	5,728		15%	36%	33.0%
Northern Alternative Energy	Autumn Hill LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,605	6,160	5,647		15%	36%	32.6%
Northern Alternative Energy	Winter Spawn LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,970	7,268	6,302		17%	42%	36.3%
Northern Alternative Energy	Twin Lake Hill LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,770	6,872	6,194		16%	40%	35.7%
Northern Alternative Energy	Spartan Hills LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,693	6,793	6,097		16%	39%	35.2%
Northern Alternative Energy	Soliloquoy Ridge LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,634	6,565	6,079		15%	38%	35.0%
Northern Alternative Energy	Ruthton Ridge LLC	MN	Wind	906N	15.84		15.8	15.8	15.8	-	2,975	7,347	6,263		2%	5%	4.5%
Northern Alternative Energy	Hope Creek LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,753	6,757	6,008		16%	39%	34.6%
Northern Alternative Energy	Hadley Ridge LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,708	6,700	6,035		16%	39%	34.8%
Northern Alternative Energy	Florence Hill LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,601	6,573	5,850		15%	38%	33.7%
Northern Alternative Energy	Agassiz Beach LLC	MN	Wind	906N	1.98		2.0	2.0	2.0	-	2,525	5,270	5,649		15%	30%	32.6%
Northern Alternative Energy	Wilmont Hill LLC	MN	Wind	906N	1.32			1.1	1.3	-	-	4,072	4,885			42%	42.2%
Windpower Partners 1993 LP	Buffalo Ridge Windplant WPP 1993	MN	Wind	906N	21.90		21.9	21.9	21.9	-	68,662	63,370	61,237		36%	33%	31.9%
Woodstock Hills LLC	Woodstock Windfarm	MN	Wind	906N	10.20		10.2	10.2	10.2	-	51,039	28,332	26,702		57%	32%	29.9%
Basin Electric Power Coop	Minot Wind	ND	Wind	906U	2.60			-	2.4			-	6,138				29.5%
FPL Energy	FPL Energy North Dakota Wind II	ND	Wind	906N	61.50			-	10.3			-	39,210				43.5%
Lincoln Electric System	Salt Valley	NE	Wind	906U	1.32			1.3	1.3	-	-	2,737	2,703		0%	24%	23.4%
FPL Energy	New Mexico Wind Energy LLC	NM	Wind	906N	204.00			-	68.2			-	182,735				30.6%
NEG	Madison Windpower	NY	Wind	906N	11.20			1.0	11.2		-	1,887	18,884		0%	23%	19.2%
FPL Energy	Oklahoma Wind LLC	OK	Wind	906N	102.00			-	17.0			-	45,134				30.2%
ESI Vansycle Partners LP	ESI Vansycle Partners LP	OR	Wind	906N	24.90		24.9	24.9	22.9	-	129,680	73,325	68,209		59%	34%	34.1%
FPL Energy	Stateline Wind	OR	Wind	906N	100.00			100.0	41.4	-	-	93,055	81,193			11%	22.4%
FPL Energy	Vancycle	OR	Wind	906N	263.40			-	132.8			-	97,817				8.4%
Klondike Wind Farm	Klondike Wind Farm	OR	Wind	906N	25.00			16.6	6.3	-	-	40,744	23,772			28%	43.1%
SeaWest WindPower Ind	Condon	OR	Wind	906N	26.40			19.6	24.2	-	-	41,518	88,685			24%	41.9%
Mill Run Windpower, LLC	Mill Run Windpower	PA	Wind	906N	15.00			13.7	13.7	-	-	34,430	39,014			29%	32.4%
Somerset Windpower, LLC	Somerset Windpower	PA	Wind	906N	9.00			6.8	7.5	-	-	15,332	17,445			26%	26.6%
Basin Electric Power Coop	Prairie Wind	SD	Wind	906U	2.60			2.6	2.6	-	-	6,043	5,695			27%	25.0%
Tennessee Eastman Division	Tenn Eastman Division	TN	Wind	906N				-	-	-	12,708	4,084	4,149				
Tennessee Valley Auth	Buffalo Mountain	TN	Wind	906U	2.10			-	1.1			-	1,832				19.8%
AEP Texas Central Company	Desert Sky Wind Project (Indian Mesa	TX	Wind	906N	160.00			-	146.8			-	344,962				26.8%
Cielo Wind Power LLC	King Mountain Wind Ranch 1	TX	Wind	906N	278.20			233.2	278.2	-	-	448,686	549,959			22%	22.6%
Delaware Mountain	Delaware Mountain Windfarm	TX	Wind	906N	30.00		30.0	12.6	27.5	-	74,017	24,038	56,116		28%	22%	23.3%
El Paso Electric Co	Hueco Mount	TX	Wind	906U	1.32			-	1.0			-	1,911				22.0%
Formosa Plastics Corp	Formosa Utility Venture Ltd	TX	Wind	906N	0.66		0.7	-	-	-	416	-	-		7%		
FPL Energy	Pecos Wind II (Woodward Mtn)	TX	Wind	906N	80.00			73.2	80.0	-	-	149,791	159,064			23%	22.7%
FPL Energy	Pecos Wind I (Woodward Mtn)	TX	Wind	906N	80.00			73.2	80.0	-	-	155,240	166,718			24%	23.8%
FPL Energy Operating System	West Texas Windplant (SW Mesa?)	TX	Wind	906N	74.90	74.9	74.9	74.9	74.9	237,103	232,451	189,563	169,540	36%	35%	29%	25.8%
New World Power Corp	Big Spring Power Facility	TX	Wind	906N	34.32		31.4	31.4	31.4	-	89,990	81,848	82,695		33%	30%	30.1%
NWP Indian Mesa Wind Farm LP	NWP Indian Mesa Wind Farm	TX	Wind	906N	82.50			75.5	82.5	-	-	165,886	181,291			25%	25.1%
Texas Wind Power Company	Llano Estacado Wind Ranch - White D	TX	Wind	906N	80.00			80.0	80.0	-	-	276,744	269,263			39%	38.4%
Tri-Cities	Trent Mesa Wind	TX	Wind	906N	150.00			150.0	150.0		-	431,731	462,420			33%	35.2%
Green Mountain Power Corp	Searsburg Wind Turb	VT	Wind	906U	6.10	6.1	6.1	6.1	6.1	12,249	12,133	11,458	10,829	23%	23%	21%	20.3%
Energy Northwest	Nine Canyon	WA	Wind	906U	48.00			28.1	48.0		-	37,782	124,300			15%	29.6%
FPL Energy	Stateline Wind	WA	Wind	906N	200.00			166.0	200.0	-	-	470,254	446,614			32%	25.5%
Badger Windpower LLC	Badger Windpower LLC	WI	Wind	906N	30.00			30.0	27.5	-	-	51,481	54,844			20%	22.8%
Madison Gas & Elec	Wind Energy	WI	Wind	906U	11.22	11.2	11.2	11.2	11.2	2,213	21,868	22,937	21,228	2%	22%	23%	21.6%
Wisconsin Electric Pwr	Byron	WI	Wind	906U	1.32	1.3	1.3	1.3	1.3	515	2,787	3,266	3,018	4%	24%	28%	26.1%
Wisconsin Public Service Corp	Lincoln Turbines	WI	Wind	906U	9.24			9.2	9.2		-	17,546	16,424			22%	20.3%
Wisconsin Public Service Corp	Glenmore Turbines	WI	Wind	906U	1.20			1.2	1.2		-	2,431	2,066			23%	19.7%
GH Drilling Inc	Backbone Mountain Wind	WV	Wind	906N	66.00			5.6	49.4		-	9,023	125,456			18%	29.0%
FPL Energy	FPL Wyoming Wind LLC	WY	Wind	906N	144.00			-	12.2			-	89				0.1%
Platte River Power Author	Medicine Bow	WY	Wind	906U	4.57	4.6	4.6	4.6	4.6	-	-	19,050	15,729			48%	39.3%
SeaWest Windpower	Rock River I LLC	WY	Wind	906N	50.00			50.0	50.0	-	-	141,390	154,660			32%	35.3%
Seawest Windpower Inc	Foote Creek I	WY	Wind	906N	41.00			-	41.0			-	127,544				35.5%
Seawest Windpower Inc	Foote Creek III	WY	Wind	906N	22.40			-	11.3			-	34,344				34.7%
Seawest Windpower Inc	Foote Creek IV	WY	Wind	906N	16.80			-	8.5			-	24,926				33.6%
Total Reporting Wind Farms					5,332.57	1,092.3	2,093.2	3,455.5	4,139.7	2,552,523	4,901,593	8,041,068	9,747,288	26.6%	26.7%	26.6%	26.9%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

		Mølle karakteristika:				2003	2004	Capacity Factor	
						Generation	Cumulative 11 mon		2004
Online Date	Project Name	Capacity (kW)	Turbine Type	Location	Type	kWh	kWh	2003 CF%	11 month
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,358,824	4,472,683	24.9%	27.9%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
27-Dec-00	Middelgrunden	2000	Bonus 2 MW	København	HAV	4,321,757	4,045,209	24.7%	25.2%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

Online Date	Project Name	Mølle karakteristika: Capacity (kW)	Turbine Type	Location	Type	2003 Generation kWh	2004 Cumulative 11 mon kWh	Capacity Factor 2003 CF%	2004 11 month
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

Online Date	Project Name	Mølle karakteristika: Capacity (kW)	Turbine Type	Location	Type	2003 Generation kWh	2004 Cumulative 11 mon kWh	Capacity Factor 2003 CF%	2004 11 month
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
17-Jun-03	Nysted	2300	BONUS 2,3	Nysted	HAV	2,585,261	7,138,592	23.8%	38.7%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
1-Sep-91	Vindeby	450	450 offshore	Ravnsborg	HAV	891,157	945,233	22.6%	26.2%
19-Dec-96		600	V 44/600 KW	Ravnsborg	HAV	1,093,839	1,074,012	20.8%	22.3%
4-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
11-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
10-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
16-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
8-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
24-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

Online Date	Project Name	Mølle karakteristika: Capacity (kW)	Turbine Type	Location	Type	2003 Generation kWh	2004 Cumulative 11 mon kWh	Capacity Factor 2003 CF%	2004 11 month
29-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
29-Aug-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
12-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
12-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
12-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
24-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
26-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
2-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
29-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
29-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
6-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
16-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
2-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
18-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
3-Sep-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
16-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
18-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
4-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
16-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
29-Oct-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
21-Aug-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
20-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
4-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

		Mølle karakteristika:				2003 Generation	2004 Cumulative 11 mon	Capacity Factor	2004
Online Date	Project Name	Capacity (kW)	Turbine Type	Location	Type	kWh	kWh	2003 CF%	11 month
17-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
20-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
7-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
16-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
17-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
18-Aug-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
24-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
4-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
20-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
19-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
15-Aug-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
30-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
1-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
4-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
6-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
20-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
27-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
27-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
29-Jul-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
20-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
10-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
25-Nov-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
11-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
5-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
10-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
4-Dec-02	Horns Rev	2000	V-80	Esbjerg	HAV	5,747,215	3,859,115	32.8%	24.1%
9-Jan-03		2000	V80-2MW	Thyborøn-Harboøı	HAV	7,153,054	7,554,739	41.7%	47.1%

Exhibit TAH-2

Danish Offshore Wind Turbine Performance

		Mølle karakteristika:				2003 Generation	2004 Cumulative 11 mon	Capacity Factor	2004
Online Date	Project Name	Capacity (kW)	Turbine Type	Location	Type	kWh	kWh	2003 CF%	11 month
23-Dec-02		2000	V80-2MW	Thyborøn-Harboøı	HAV	7,153,054	7,554,739	40.8%	47.1%
23-Dec-02		2000	V80-2MW	Thyborøn-Harboøı	HAV	7,153,054	7,554,739	40.8%	47.1%
8-Jan-03		2000	V80-2MW	Thyborøn-Harboøı	HAV	7,153,054	7,554,739	41.7%	47.1%
24-Jan-03		2300	2,3MW	Thyborøn-Harboøı	HAV	6,702,901	7,928,055	35.6%	43.0%
29-Jan-03		2300	2,3MW	Thyborøn-Harboøı	HAV	6,702,901	7,928,055	36.1%	43.0%
28-Jan-03		2300	2,3MW	Thyborøn-Harboøı	HAV	6,702,901	7,928,055	36.0%	43.0%
21-Jan-03		2300	2,3MW	Thyborøn-Harboøı	HAV	6,702,901	7,928,055	35.3%	43.0%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
30-May-95	Tunø Knob	500	V39	Odder	HAV	1,229,165	1,270,974	28.1%	31.7%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	6,039,307	7,425,505	33.6%	40.3%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	6,003,478	7,549,496	33.4%	40.9%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,922,290	7,435,799	32.9%	40.3%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,897,629	6,369,262	32.8%	34.5%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,874,978	7,389,436	32.6%	40.1%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,861,691	7,341,631	32.6%	39.8%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,929,071	7,396,149	32.9%	40.1%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,903,358	7,418,367	32.8%	40.2%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,905,855	7,267,819	32.8%	39.4%
8-Feb-03	Samsø	2300	Bonus 2,3 MW	Samsø	HAV	5,942,948	7,547,967	33.0%	40.9%
16-Apr-03	Frederikshavn	2300	2,3MW	Frederikshavn	HAV	4,160,190	6,155,063	29.1%	33.4%
20-Jun-03	Frederikshavn	3000	V90--3,0MW	Frederikshavn	HAV	1,965,318	4,356,378	14.1%	18.1%
28-May-03	Frederikshavn	2300	N90-2300	Frederikshavn	HAV	2,620,038	6,771,398	21.9%	36.7%
	Total	423,950				879,359,966	1,084,423,531	29.4%	31.9%

Source: Danish Government website for public assisted wind projects: http://www.ens.dk/graphics/ENS_StatistikogData/statistik/EnergiData/Vindregis

Exhibit TAH-3
Cape Wind Estimated Performance
Estimated Using NOAA Wind Speed Data for Nantucket Sound

NOAA Station 44018 - SE Cape Cod 30NM East of Nantucket, MA

41.3 N 69.2 W (41°15'30" N 69°17'42" W)

Monthly averages

	Average Wind Speed (m/s)		Per Turbine Gross Power Output (kWh)		Gross Capacity	% Annual Power
	Station	Adj	Raw	Adj	Factor%	Output
January '03	10.85	12.27	1,267,196	1,525,332	56.9%	15.7%
February '03	10.20	11.54	1,131,121	1,367,095	56.5%	14.1%
March '03	8.36	9.46	701,748	914,346	34.1%	9.4%
April '03	8.02	9.07	662,907	885,326	34.2%	9.1%
May '03	8.72	9.87	254,232	354,592	13.2%	3.7%
June '03	4.46	5.04	186,764	262,102	10.1%	2.7%
July '03	4.82	5.45	174,905	257,000	9.6%	2.6%
August '02	5.80	6.56	230,874	338,114	12.6%	3.5%
September '02	5.35	6.06	246,259	343,989	12.8%	3.5%
October '02	8.61	9.74	627,090	839,285	31.3%	8.6%
November '02	8.62	9.75	947,977	1,154,759	44.6%	11.9%
December' 02	10.55	11.93	1,218,839	1,472,690	55.0%	15.2%
	7.86	8.89	7,649,911	9,714,631	30.8%	100.0%

Cape Wind Total Project Maximum output before losses- MWh	1,262,902	30.8%
Estimated losses due to planned and unplanned outages- MWh	(212,023)	
Total Net Project Output- MWh	1,050,879	25.6%

NOTE: Increased NOAA raw wind speed data by 13.1% to reflect Draft EIS average wind speed of 8.89 m/s

Army Corp Draft EIS Avg Wind Speed Adjustment		
Avg wind spd	8.89	
	1.13	Adjustment factor

Losses- Planned and unplanned		
95%	Turbine Availability (97% for land based)	
9.7%	Forced Outage Rate	
	5.0%	Icing/Fouling
	1.0%	Cold weather
	3.7%	Array losses
3%	Transmission Losses (per EIS)	

Exhibit TAH-4

Cape Wind Output Projections Using Elevation Adjustment of Monitoring Tower Readings

	Month	Reading Minutes	Min/mo	% Availability	Avg Wind Speed m/s Monitor	@75M	Per Turbine Output-kWh unadj-kWh	Adj-kWh	Max Potential CF unadj	Adj
2003	9	35,194	43,200	81%	6.44	7.77	488,829	783,497	19%	30.2%
	10	32,388	44,640	73%	8.36	10.10	946,561	1,312,011	35%	49.0%
	11	42,709	43,200	99%	8.38	10.12	868,941	1,102,024	34%	42.5%
	12	43,716	44,640	98%	10.28	12.42	1,374,293	1,689,389	51%	63.1%
2004	1	12,024	44,640	[illegible]	11.60	14.01	1,676,995	2,013,597	63%	75.2%
	2	40,116	41,760	96%	7.49	9.05	717,464	1,032,333	29%	41.2%
	3	38,424	44,640	86%	8.68	10.49	993,408	1,404,158	37%	52.4%
	4	40,491	43,200	94%	7.28	8.80	705,508	1,039,012	27%	40.1%
	5	40,496	44,640	91%	6.47	7.81	511,900	830,533	19%	31.0%
	6	41,380	43,200	96%	6.34	7.65	482,032	772,179	19%	29.8%
	7	43,192	44,640	97%	5.82	7.03	366,503	610,968	14%	22.8%
	8	43,737	44,640	98%	6.46	7.80	472,420	793,863	18%	29.6%
	9	41,829	44,640	94%	6.93	8.37	607,701	884,093	23%	33.0%
	10	44,645	44,640	100%	7.66	9.25	873,076	1,173,468	33%	43.8%
	11	43,195	43,200	100%	8.01	9.68	925,214	1,219,363	36%	47.0%
	12	14,238	44,640	[illegible]	9.34	11.28	1,193,467	1,594,251	45%	59.5%
Annual		597,773	704,160	90%	7.75	9.36	9,525,689	13,367,818	30.1%	42.3%
Most of January 2004 data missing- Replaced with December 2003 data since NOAA December ar							(302,702)	(324,208)		
Estimated 2004 Annual Gross Maximum Ouput per turbine before losses kWh						9.13	9,222,987	13,043,610	29.2%	41.2%

Cape Wind Total Project Maximum output before losses- MWh	1,695,669	41.2%
Estimated losses due to planned and unplanned outages- MWh	(289,174)	
Total Net Project Output- MWh	1,406,495	34.3%

Note: Adjusted all Cape Wind Monitoring station raw wind speed data by 21% to reflect elevation difference between 75 and 20 meters

Elevation Adjustment between monitoring tower and proposed turbine height	
Wind Turbine 75	meters
Monitoring To 20	meters
1.21	Adjustment factor
Losses- Planned and unplanned	
95%	Turbine Availability
9.7%	Forced Outage Rate
5.0%	Icing/Fouling
1.0%	Cold weather
3.7%	Array losses
5%	Transmission Losses

Exhibit TAH-4a

Cape Wind Output Projections Based Upon 8.89 m/sec Average Wind Speed

		Reading			Avg Wind Speed m/s			Per Turbine Output-kWh		Max Potential CF	
Month		Minutes	Min/mo	% Availability	Monitor	@75M		unadj-kWh	Adj-kWh	unadj	Adj
2003	9	35,194	43,200	81%	6.44		7.38	488,829	701,325	19%	27.1%
	10	32,388	44,640	73%	8.36		9.59	946,561	1,212,994	35%	45.3%
	11	42,709	43,200	99%	8.38		9.61	868,941	1,050,734	34%	40.5%
	12	43,716	44,640	98%	10.28		11.79	1,374,293	1,609,394	51%	60.1%
2004	1	12,024	44,640	[illegible]	11.60		13.31	1,676,995	1,929,373	63%	72.0%
	2	40,116	41,760	96%	7.49		8.59	717,464	948,307	29%	37.8%
	3	38,424	44,640	86%	8.68		9.96	993,408	1,291,731	37%	48.2%
	4	40,491	43,200	94%	7.28		8.35	705,508	948,582	27%	36.6%
	5	40,496	44,640	91%	6.47		7.42	511,900	736,246	19%	27.5%
	6	41,380	43,200	96%	6.34		7.27	482,032	688,663	19%	26.6%
	7	43,192	44,640	97%	5.82		6.67	366,503	539,469	14%	20.1%
	8	43,737	44,640	98%	6.46		7.40	472,420	698,340	18%	26.1%
	9	41,829	44,640	94%	6.93		7.95	607,701	806,123	23%	30.1%
	10	44,645	44,640	100%	7.66		8.78	873,076	1,096,659	33%	40.9%
	11	43,195	43,200	100%	8.01		9.19	925,214	1,145,310	36%	44.2%
	12	14,238	44,640	[illegible]	9.34		10.72	1,193,467	1,493,910	45%	55.8%
Annual		597,773	704,160	90%	7.75		8.89	9,525,689	12,322,712	30.1%	39.0%
Most of January 2004 data missing- Replaced with December 2003 data since NOAA December and Januai								(302,702)	(319,979)		
Estimated 2004 Annual Gross Maximum Ouput per turbine before losses kWh							8.67	9,222,987	12,002,734	29.2%	37.9%
Cape Wind Total Project Maximum output before losses- MWh									1,601,953		37.9%
Estimated losses due to planned and unplanned outages- MWh									(307,695)		
Total Net Project Output- MWh									1,294,257		31.6%

Note: Adjusted all Cape Wind Monitoring station raw wind speed data by 15% to reach 8.89 m/s average wind speed reported in Draft EIS

Army Corp Draft EIS Avg Wind Speed Adjustment	
Avg wind spd 8.89	m/s
1.15	Adjustment factor
Losses- Planned and unplanned	
95%	Turbine Availability
9.7%	Forced Outage Rate
5.0%	Icing/Fouling

Exhibit TAH-4b

Cape Wind Output Calculations Based Upon 8.5 m/sec Average Wind Speed From New England Wind Map

Month		Reading Minutes	Min/mo	% Availability	Avg Wind Speed m/s Monitor	@75M	Per Turbine Output-kWh unadj-kWh	Adj-kWh	Max Potential CF unadj	Adj
2003	9	35,194	43,200	81%	6.44	7.06	488,829	627,064	19%	24.2%
	10	32,388	44,640	73%	8.36	9.17	946,561	1,122,682	35%	41.9%
	11	42,709	43,200	99%	8.38	9.19	868,941	999,027	34%	38.5%
	12	43,716	44,640	98%	10.28	11.28	1,374,293	1,534,154	51%	57.3%
2004	1	12,024	44,640	[illegible]	11.60	12.72	1,676,995	1,850,692	63%	69.1%
	2	40,116	41,760	96%	7.49	8.22	717,464	871,543	29%	34.8%
	3	38,424	44,640	86%	8.68	9.52	993,408	1,190,920	37%	44.5%
	4	40,491	43,200	94%	7.28	7.99	705,508	866,320	27%	33.4%
	5	40,496	44,640	91%	6.47	7.09	511,900	654,600	19%	24.4%
	6	41,380	43,200	96%	6.34	6.95	482,032	615,669	19%	23.8%
	7	43,192	44,640	97%	5.82	6.38	366,503	476,947	14%	17.8%
	8	43,737	44,640	98%	6.46	7.08	472,420	615,900	18%	23.0%
	9	41,829	44,640	94%	6.93	7.60	607,701	737,413	23%	27.5%
	10	44,645	44,640	100%	7.66	8.40	873,076	1,025,602	33%	38.3%
	11	43,195	43,200	100%	8.01	8.79	925,214	1,075,363	36%	41.5%
	12	14,238	44,640	[illegible]	9.34	10.25	1,193,467	1,399,181	45%	52.2%
Annual		597,773	704,160	90%	7.75	8.50	9,525,689	11,380,150	30.1%	36.0%
Most of January 2004 data missing- Replaced with December 2003 data since NOAA December and January wind							(302,702)	(316,538)	Jan adj	
Estimated 2004 Annual Gross Maximum Ouput per turbine before losses kWh						8.29	9,222,987	11,063,613	29.2%	35.0%

Cape Wind Total Project Maximum output before losses	1,479,420	35.0%
Estimated losses due to planned and unplanned outages- MWh	(286,428)	
Total Net Project Output- MWh	1,192,992	29.1%

Note: Adjusted all Cape Wind Monitoring station raw wind speed data by 10% to reflect New England Wind Map average spped of 8.5 m/s for region at 70 meters

NE Wind Map Avg Wind Speed Adj		
8.50	m/s	
1.10	Adjustment factor	
Losses- Planned and unplanned		
95%	Turbine Availability	
9.7%	Forced Outage Rate	
	5.0%	Icing/Fouling
	1.0%	Cold weather
	3.7%	Array losses
3%	Transmission Losses	

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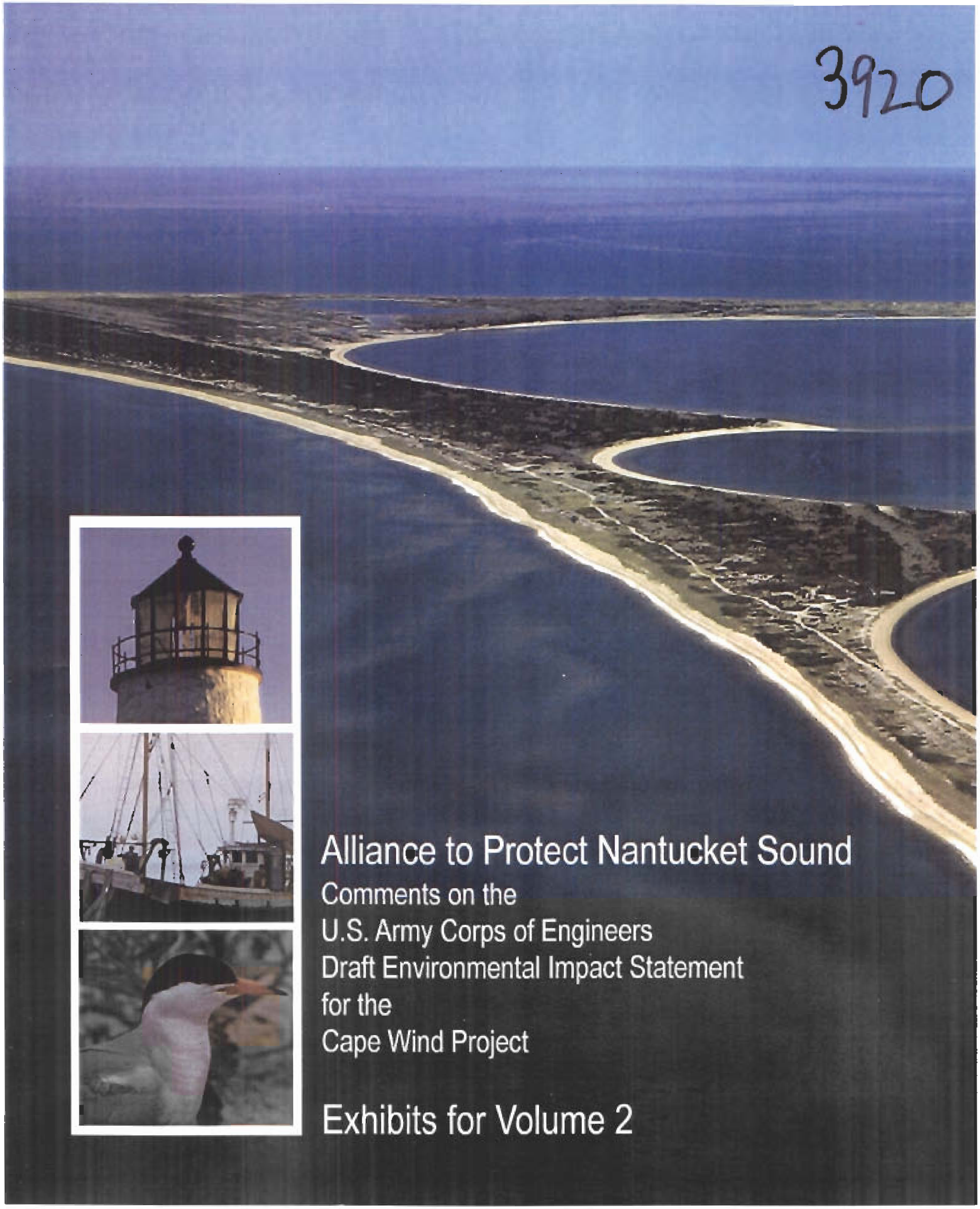

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Alliance to Protect Nantucket Sound

Comments on the
U.S. Army Corps of Engineers
Draft Environmental Impact Statement
for the
Cape Wind Project

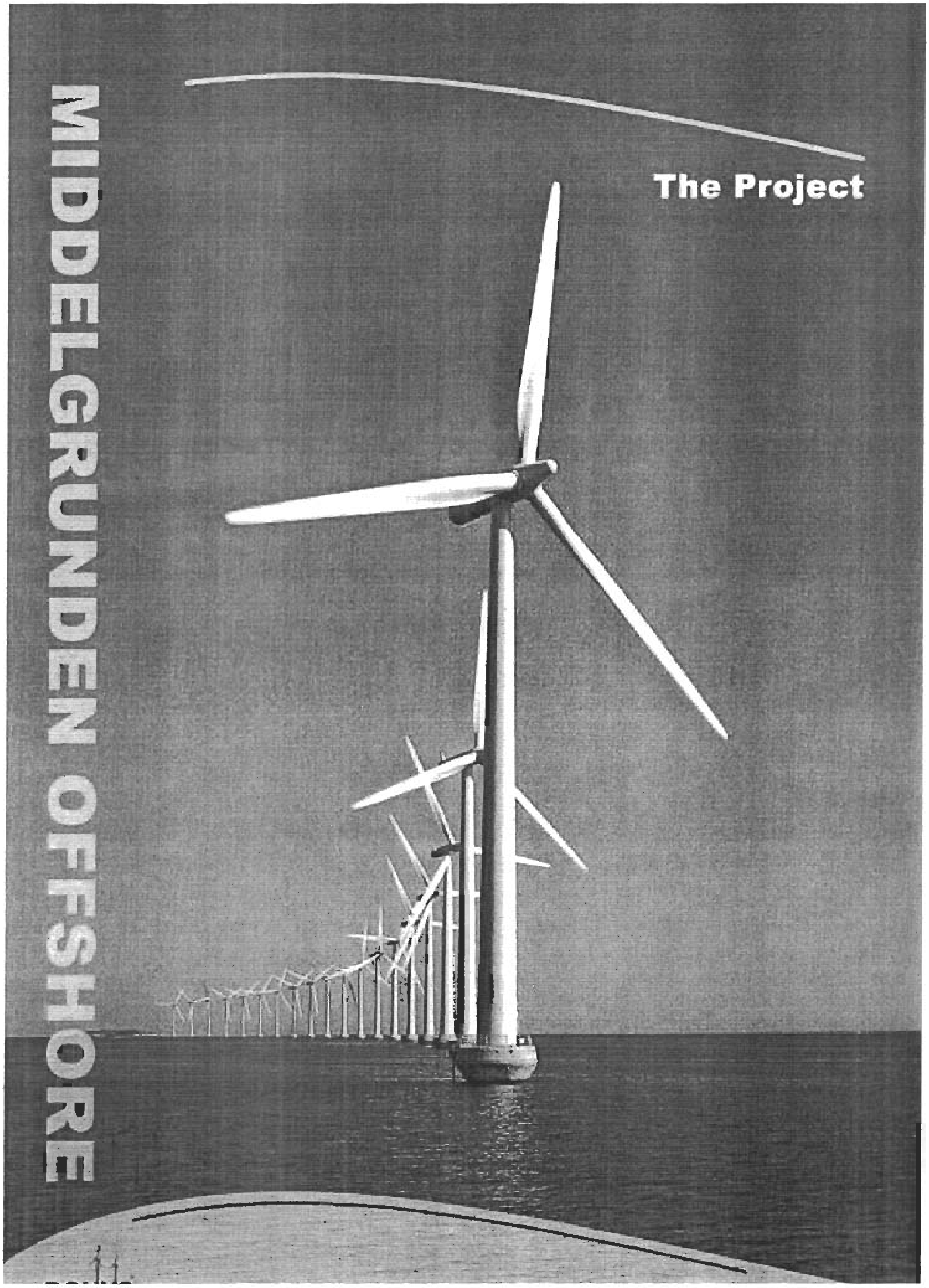
Exhibits for Volume 2

Parts 1 – 9

February 24, 2005

EXHIBITS FOR VOLUME 2 (1-9)

Exhibit No.	Description
1	BONUS Energy A/S, "Middlegrunden Offshore, A newsletter for customers and business associates," July 2001.
2	Giuffre, D., "Public Health Impacts and Economic Costs from Power Plant Emissions," Statement at public hearing held by Corps and MEPA, Dec. 7, 2004.
3	Haughton, J., "Economic Costs Exceed Economic Benefits for the Cape Wind Project," Statement at public hearing held by Corps and MEPA, Dec. 16, 2004.
4	Howard, M. and C. Brown, "Results of the electromagnetic investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle wind farm by QinetiQ and the Maritime and Coastguard Agency," MCA No. MNA 53/10/366, Nov. 22, 2004.
5	Keyser, K.M., QM1, USCGC *Bittersweet* (WLB-389), "Waterways Analysis and Management Survey of Nantucket Sound Main Channel, Pollock Rip Channel and Great Round Shoal Channel," Oct. 10, 1996.
6	Letter from Capt. M.E. Landry (USCG), to Col. Thomas L. Koning (Corps), July 12, 2004.
7	Letter from Capt. M.E. Landry (USCG), to Col. Thomas L. Koning (Corps), February 14, 2005.
8	Massachusetts Fishermen's Partnership, "Commercial Fishing in Nantucket Sound: Considerations pertinent to the proposed wind farm on Horseshoe Shoals," April 2004.
9	National Research Council, Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems, "Valuing Ecosystem Services: Toward Better Environmental Decision-Making," National Academies Press, 2004.


MIDDELGRUNDEN OFFSHORE
The Project

CONTENTS

EDITORIAL

During the winter 2000-2001 an offshore wind farm, consisting of 20 units of Bonus 2 MW wind turbines, was constructed on the Middelgrunden near Copenhagen.

This project is a large step forward for Bonus. The Middelgrunden project is not only the first Danish, but also the world's first large scale offshore wind farm. It is also the first offshore wind farm utilizing a wind turbine of a type expected to be dominant for large offshore projects in the near future. Additionally, it is also Denmark's largest wind farm, both on land and at sea.

The future goal of the Danish government is to cover up to 50 % of the Danish electricity supply by offshore wind turbines. The Middelgrunden project is the first step in this direction. As soon as the contract for future delivery of wind turbines was signed in December 1999, we therefore decided that the construction of the project would be closely followed, so that the story of the Middelgrunden offshore could be written. This newsletter is the result.

Previously a series of articles on the general construction and operation of a modern wind turbine have been published in different issues of our newsletter Bonus-Info. Following several requests, these series have been re-issued as one special edition, which may be obtained on request from the Bonus service department. We will therefore refrain from describing wind turbine technical details in this issue, and primarily concentrate on the project's infrastructure and constructional operations.

We hope that this newsletter will give our customers and business associates an impression of the effort and cooperation necessary to build a new and epoch-making project like the Middelgrunden.

Middelgrunden Offshore
A newsletter for customers and business associates.

Published
1 July 2001

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Text/layout
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Translation
John Furze

Proofreading
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Printing
Isager Bogtryk/Offset, 5700 Svendborg

Number Printed:
1500 copies

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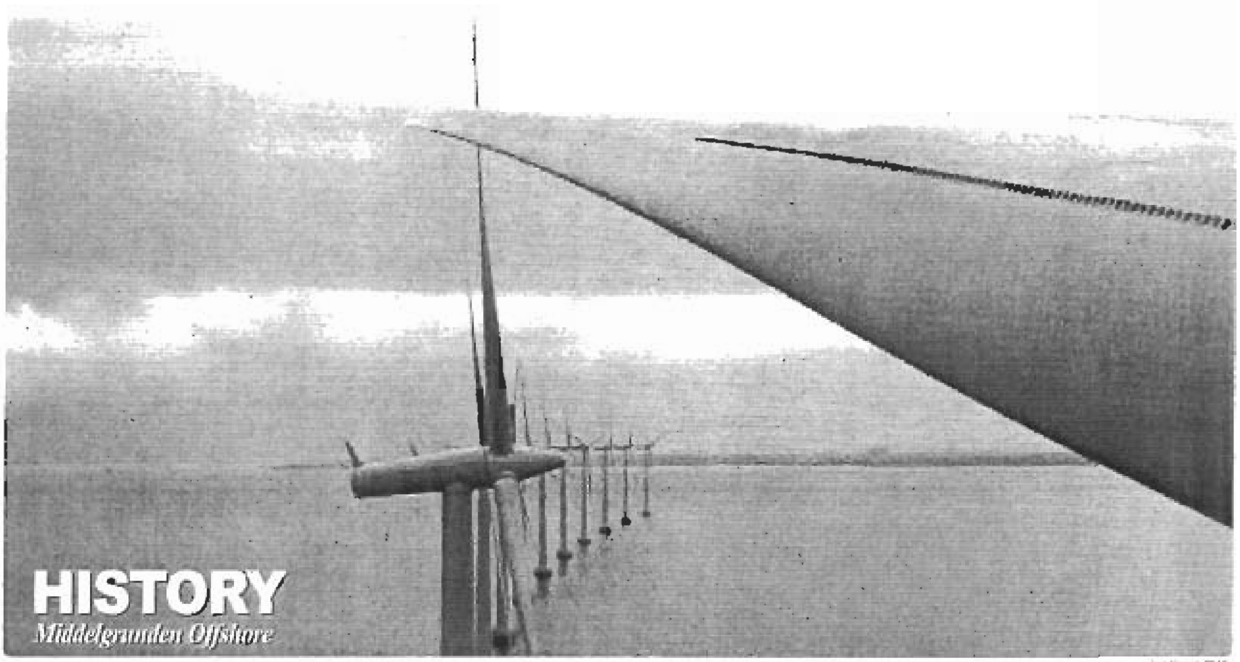


During the past 20 years, windturbines have become an integrated and everyday sight in the Danish landscape, and wind turbines have now started to operate offshore.

The world's first offshore wind turbine farm with 11 units of 450 kW wind turbines was erected at Vindeby near the island of Lolland, in 1991 by Bonus Energy A/S, Denmark.

In the future, many offshore wind turbines will follow. Danish public energy planning foresees that an offshore wind turbine capacity of app. 4.000 MW will be installed.

As part of this process the Middelgrunden offshore wind farm was commissioned on the 6th of May 2001. Twenty Bonus 2 MW wind turbines was installed on the Middelgrunden, a shallow reef out in the Øresund, the belt between Sweden and Denmark. At the time of writing, this was the largest offshore wind turbine project in the world.

There is between 1.7 and 3.5 kilometres from the wind farm to the nearest quay in Copenhagen Harbour, thus giving good possibilities for the wind to blow unobstructed in all directions and ensuring a good energy production calculated to be app. 85.000 MWh per. year. This covers 3% of Copenhagen's annual energy consumption, or the annual electricity consumption of the 32.000 apartments in the nearest Copenhagen suburb of Christianshavn.

INITIATIVE GROUP

The project was initiated in 1996 by the group behind another Copenhagen wind turbine cooperative, Lynetten Vindkraft I/S, and the Københavns Energi og Miljokontor, a local NGO.

Later that same year Københavns Energi, the municipal electricity utility, joined the project. Contact was established with authorities and organizations having a special interest in the Middlegrunden.

From 1997 to 1998, the Middelgrunden project was subject to a legally required public-hearing phase. In addition to the funds provided by the electrical generating companies, a grant of DKK 5.1 million was provided by the Danish Energy Agency for preliminary investigations.

A building permit was received in 1999, and following a round of tenders, contracts were signed with the chosen contractors in January 2000 at the Copenhagen Town Hall.

OWNERS

The legal owners and those responsible for issuing the tender documents are the Middelgrund Wind Turbine Cooperative and Københavns Energi, who each own 10 wind turbines.

The 40.000 shares of the cooperative are mainly sold in small portions to a broad section of the Copenhagen public.

The electricity generating utility company SEAS, having a long wind power tradition, has been managing the project in the constructional phase.

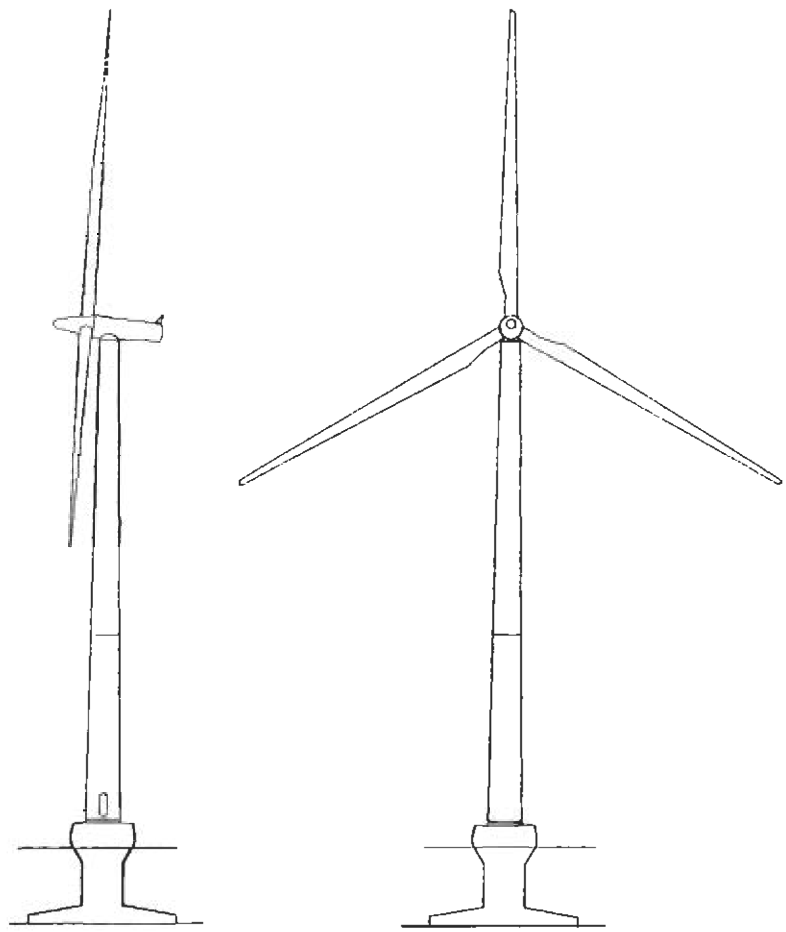
COOPERATION

The cooperation between the two owners is a continuation of a previous cooperation in connection with the wind turbine projects at Avedøre Holme and Lynetten.

The cooperative's intention with the project is to give the residents of Copenhagen the possibility of participating in a local and ecological energy supply system. The intentions of the utilities are to gather useful experience, while generating energy for the growing needs of Copenhagen.

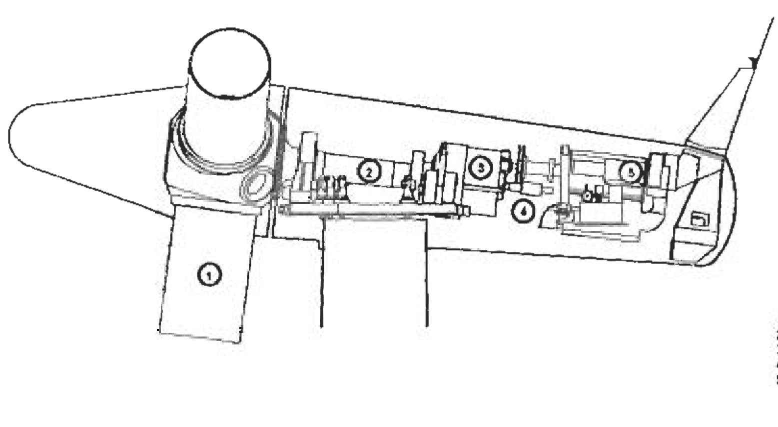
The following pages describe the different aspects of the project and the work processes during the various constructional phases. Likewise the environmental considerations are presented.

THE WIND TURBINE



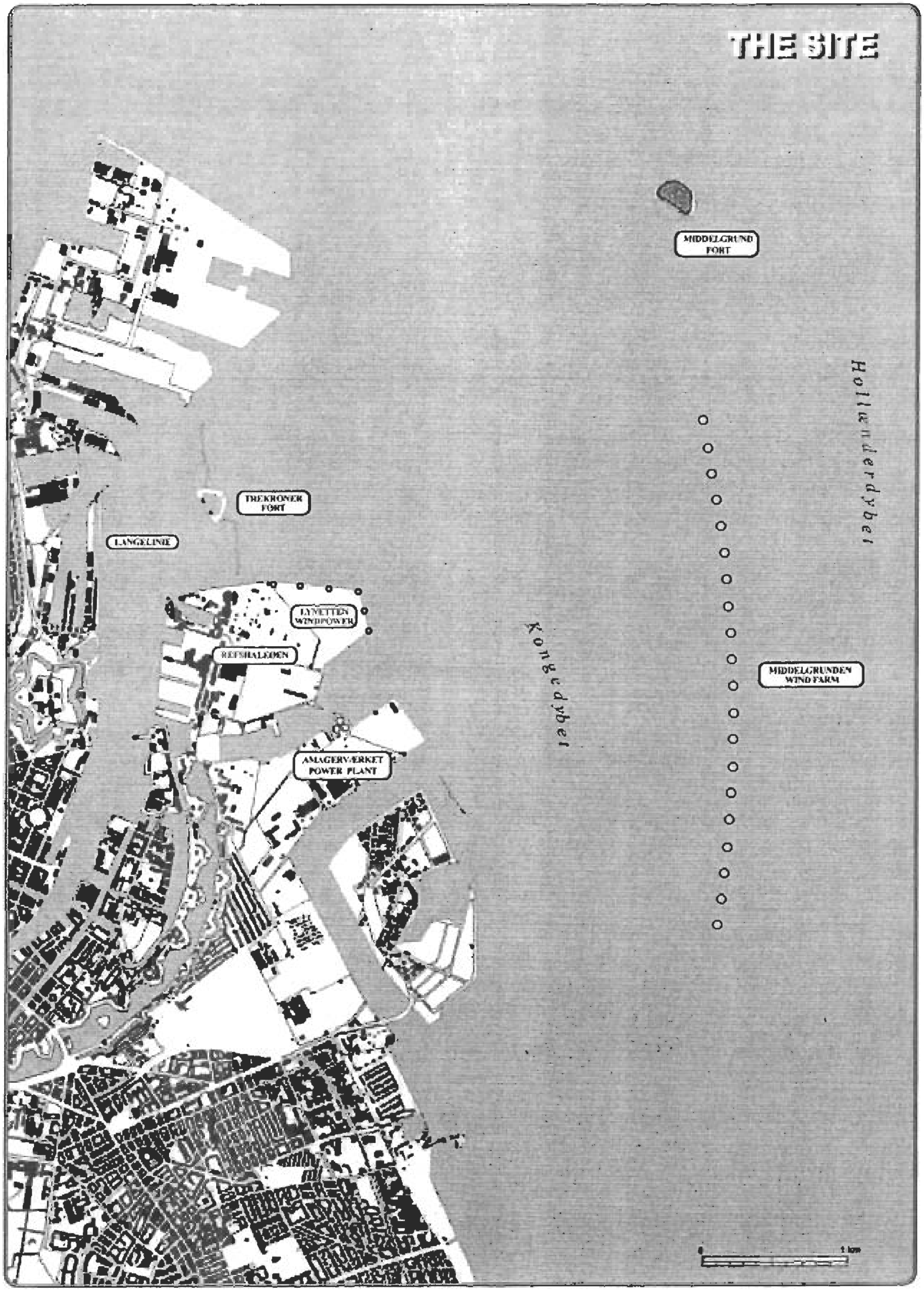
HUB HEIGHT ABOVE OCEAN: 64 m
ROTORDIAMETER, 76 m

BONUS 2 MW



1 BLADES
2 MAIN SHAFT
3 GEARBOX
4 BRAKE
5 GENERATOR

NACELLE BONUS 2 MW


THE SITE
MIDDELGRUND FORT
Hollænderdybet
TREKRONER FORT
LANGELINIE
LYNETTEN WINDPOWER
REFSHALEØEN
Kongedybet
MIDDELGRUNDEN WIND FARM
AMAGERVÆRKET POWER PLANT
0
1 km

FOUNDATION PREPARATION

A construction vessel places crushed stone

Until the middle of the 1980ies, large amounts of dredged harbour sludge and building rubble have been dumped in the Middelgrunden.

The exact extent of the possible environmental damage resulting from this dumping activity is only partly known.

SONAR MEASUREMENTS

During preliminary investigations, sonar measurements are made. Sound waves are transmitted from a ship down to the seabed and reflected back to a sensitive measuring equipment on the ship, thereby mapping the seabed and giving warnings of possible obstructions.

SAMPLING

During the autumn of 1999, site-specific testing follows these sonar measurements. Directly above the proposed site for each foundation, a so-called seafloor rig vibrates rods down into the seabed. The tip of each rod is fitted with a probe measuring the pressure, also enabling it to determine the condition of the seabed at various depths. As the dumped sludge is rather soft, the main purpose with these tests is to determine the future profile shape of the trench that must be excavated in order to reach a solid ground for the foundation to rest upon.

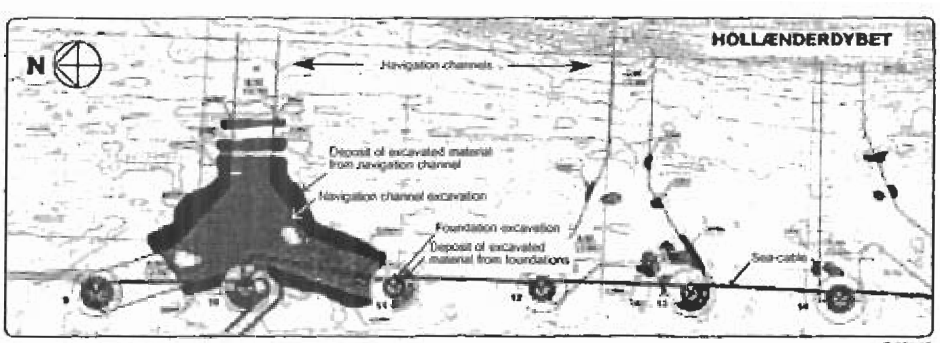
THE CONSTRUCTION FLEET

During August and September 2000, most of the preparatory excavation was carried out by a fleet of 7-8 construction vessels, floating hydraulic excavators, equipped with "legs" stuck down into the seabead keeping them stable during operations.

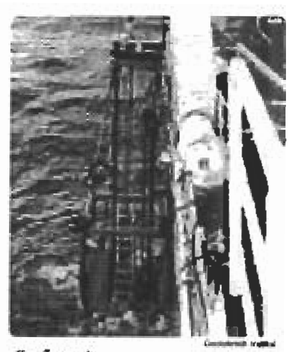
NAVIGATION CHANNELS

Next, navigation channels enabling all future transport to the turbines are being excavated.

The wind turbines are placed in a shallow north-south arc on the eastern end of the Middelgrunden.



Plan for excavations



Seafloor rig

The water depth is rather low, only app. 3-5 metres due to the large amounts of dumped sludge from here towards Copenhagen. The passage to the wind turbine navigation channels must therefore go north of the northernmost wind turbines. Wind turbine navigation channels are thus all approached from the Hollænderdybet, a navigation channel for large commercial ships.

EXCAVATION

It is almost impossible to prevent spilling a portion of the dumped sludge and mud, thereby releasing it to the local environment.

Investigations have shown that some of the dumped material is polluted. Therefore no excavated material is brought to the surface or deposited onshore, which would have resulted in an even larger disturbance in the water and thereby an even larger spillage.

Careful operation prevents spillage from exceeding 5%, which is acceptable due to rapid dissolving by the local water current.

Following clearance of the navigation channels, the same technology is used to scrape and remove the sludge from the foundation sites. Subsequently, another 1-3 metres of seabed is further excavated until the required excavated profile of app. 6-8 metres below the surface has been obtained.

DIVER INSPECTION.

The above task is finalized by a diver inspection and a series of so-called "wing-tests". A drill fitted with a wing is bored into the seabed. Turning the drill indicates the strength of the resistance and whether the seabed is solid and hard enough.

AIRLIFT CLEANING

By means of an airlift pump, the excavated profile is cleaned for small deposits not removed during the excavation process. Air is forced down to the seabed in special tubes, and the air then rises transporting the remaining sludge and debris to the surface.

CUSHION LAYER

The foundation area is now ready for the divers to install a levelling machine for crushed stone. It is a steel girder equipped with water jets running on steel rails.

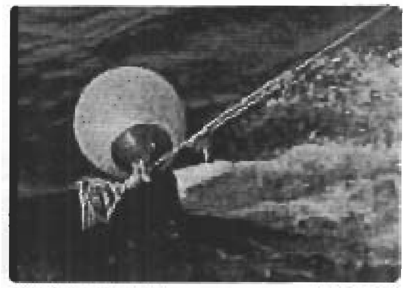
A load of crushed stone is placed between the rails. A diver operated hydraulic winch drags the girder along the rails using the water jets to further move the pile of crushed stones, enabling the construction of a 0.5 metre cushion layer.

Following removal of the levelling machine, the cushion layer edge is ajusted by the diving team, and another quality control inspection is made. To prevent erosion, a fibre fabric is laid over the cushion layer.

VIBRATION.

A 2 x 2 metrehydraulic plate vibrator, lowered and operated from a construction vessel, finally vibrates the cushion layer.

Vibration consolidates the crushed stones, ensuring that the cushion layer remain stabile, when operational vibrations from the wind turbine are transmitted down into the foundation.

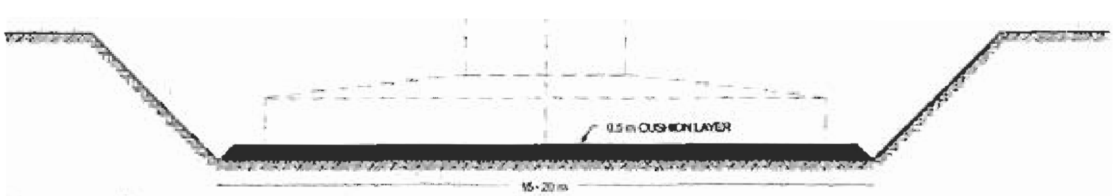


Airlift pump cleaning Jens Hansen, SEAS

Crushed stone Jens Hansen, SEAS

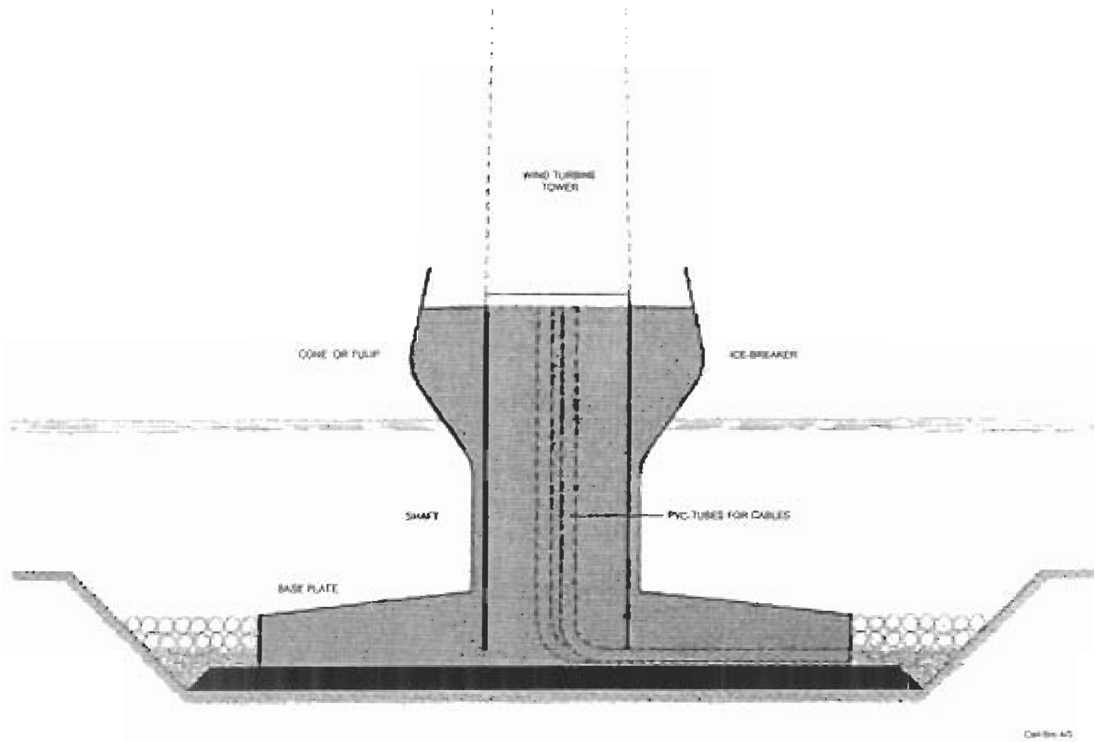
Girder for levelling machine Jens Hansen, SEAS

Construction vessel lowers vibrator Jens Hansen, SEAS



Excavation profile

THE FOUNDATION



The foundations of the 20 wind turbines on the Middelgrunden site are based on new calculation methods.

GRAVITATIONAL FOUNDATION

Carl Bro A/S made the foundation design, and describes it as a gravitational foundation, i.e. the total weight of the foundation and the wind turbine gives the necessary stability.

The individual foundation height and weight varies slightly according to the depth of the different sites. The average onshore weight of a foundation for the Middelgrunden is app. 2.000 tonnes. When submerged, the water adds lift, and the weight is reduced to app. 1.500 tonnes.

COMPOSITE CONSTRUCTION

The engineers from Carl Bro A/S refer to the foundation as "a pure steel construction enclosed by reinforced concrete".

Specialists call such a design, composed of different materials, a composite construction.

The different qualities of the materials make such a construction difficult to calculate, as the physical properties of the materials can differ by a factor of up to 10 e.g in their expansibility and elasticity.

NEW CALCULATION METHOD

Although calculations of concrete and steel composite constructions can be difficult, they are all part of normal engineering practice.

However, normal practice is not quite sufficient when the foundation is out in the sea supporting a 60 meter high steel tower with a set of rotating wind turbine blades of 76 meters in diameter.

A new approach to construction calculation was necessary for Carl Bro A/S. In addition to considering the different variable forces from waves and ice masses, they had to take into consideration the wind turbine industry's rather different view on loads.

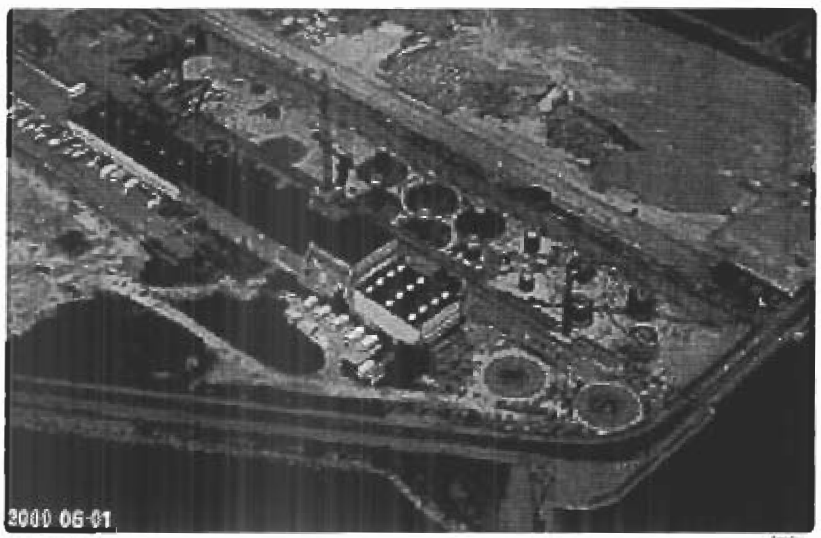
Putting all these different loads together, under the worst possible circumstances, resulted in a 25-30% increase in the size of the foundations and an unacceptable cost for the project holders.

In dialog with the certification agency, Det Norske Veritas DNV, a new calculation model was developed, based on the statistical possibilities for combinations of the different loads.

The work on the foundations to the Middelgrunden wind farm has given an important contribution to the new load standards for offshore wind turbines, published by the Danish Energy Agency in March 2001.

CONSTRUCTION OF FOUNDATIONS

1992: Shipbuilding in the B&W's dry dock



2000 Construction of wind turbine foundations in the B&W dry dock

The foundations for the wind turbines were made in the dry dock in the former Burmeister & Wain shipyard at Refshaleøen.

REFSHALEØEN

The passage into Copenhagen Harbour lies between the Langeline and Refshaleøen, a man made peninsula of great significance for many people in Copenhagen. In 1843, the famous Burmeister & Wain Skibsværft purchased Refshaleøen. 1000 ships were built, until the yard was shut down in 1996.

As far back as the 1970ies, over 3.000 workers from Copenhagen were employed here.

Visiting Refshaleøen today, the whole area is marked by the presence of a former shipyard. Many of the large, old buildings look dilapidated and abandoned, while elsewhere there are signs of new small industries. Piles of old and new machine components and sections of construction machinery lie everywhere.

Following a short security control at the main entrance, we turn right and drive east catching sight of rotating wind turbine blades, indicating that already some years ago, wind power took a foothold in the area. In 1996, seven Bonus 600 kW wind turbines were installed on the quay at the Lynetten sewage plant on the north-eastern part of Refshaleøen.

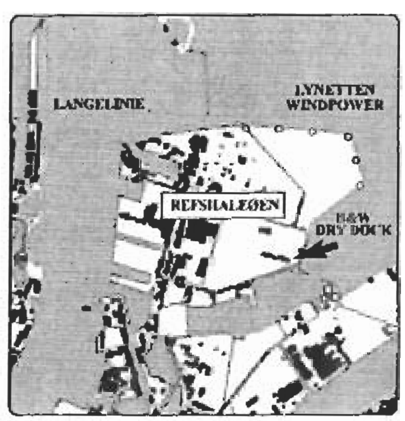
THE B&W DRY DOCK

We have been instructed to turn right driving east towards "Siberia", so named by the former shipyard workers, as the area was situated far from the rest of the yard's other buildings. Also, it was windy and cold, even during the summertime.

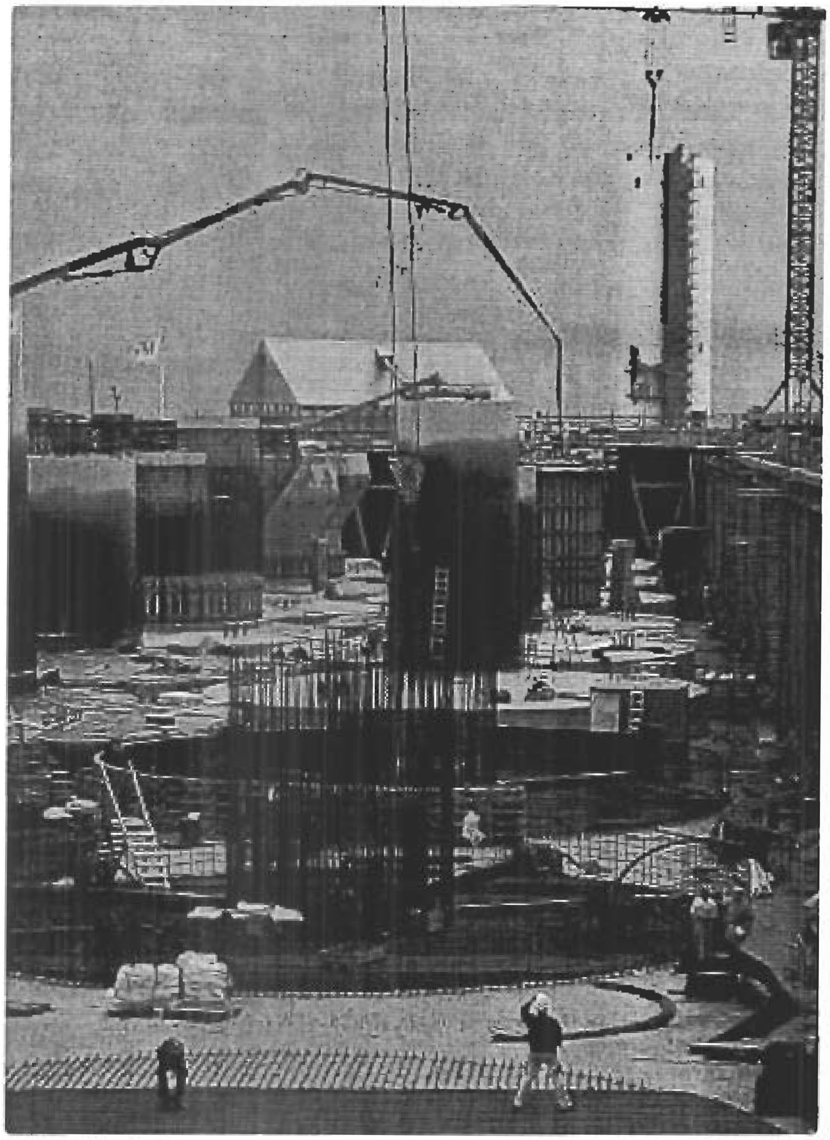
Here lies the old B&W dry dock, a large, long and deep hole in an otherwise flat landscape. At one end, facing the belt of Øresund, a dock-gate opens enabling water to fill the bassin. When the gate is shut, the dock can be emtied once again.

Large sections of ships were assembled and fitted-out in the dry dock. However, since the last ship left the dock, it has remained inactive.

In 2000, the construction companies of Monberg & Thorsen and Phil & Søn formed a syndicate, for the construction and transport of the foundations for the Middelgrunden wind farm. The dry dock had the ideal size and site for the purpose, and it was filled with life once again.



Refshaleøen



Work in the dry dock

Steel fixing

After lying abandoned for over eight years, work restarts in the dock in January 2000, with the construction of the 20 foundations for the Bonus 2 MW wind turbines.

Firstly, the bottom of the dock is cleaned and levelled. Secondly the foundation base plate outlines are marked with colour. As shown in the drawing on the opposite page, there is just enough room for all 20 foundations.

A track for two large cranes is laid along one side. Later in the process a third crane is added to the site.

Just behind the crane track, a two storeyed city is erected. It consists of grey and blue site-huts with facilities for workers and engineers. There is also a row of containers, well equipped with welding and cutting equipment, and a broad selection of steel working tools.

The actual work on the foundations starts in March. While the first trucks with steel reinforcing bars drive up alongside the dock, the workers descend down into the dock by two steep stairways.

Soon the cranes are lowering steel bundles and tools. Each time the cranes move along the tracks, an alarm bell rings to warn of possible danger.

The large photo above taken in midsummer shows the site in full activity. The site-huts are situated to the right behind the crane. This is the base for the 25-30 construction workers. From their accents we can hear that there is also a group from Skåne, which is situated just across the water in Sweden. We think of the new Øresund Bridge, which can be seen in the distance, south of the site. Four-five engineers and some foremen from the construction syndicate coordinate the work from the office huts by telephones, computers, meetings, and frequent visits down to the dock.

STEEL FIXING.

The workers tie the steel reinforcing bars in a complex net, later to be filled with concrete, giving the foundation the necessary strength.

The bars are tied together with thin wires. Angle grinders and cutting torches howl and shower sparks, where the steel has to be shortened or bent in a special way.

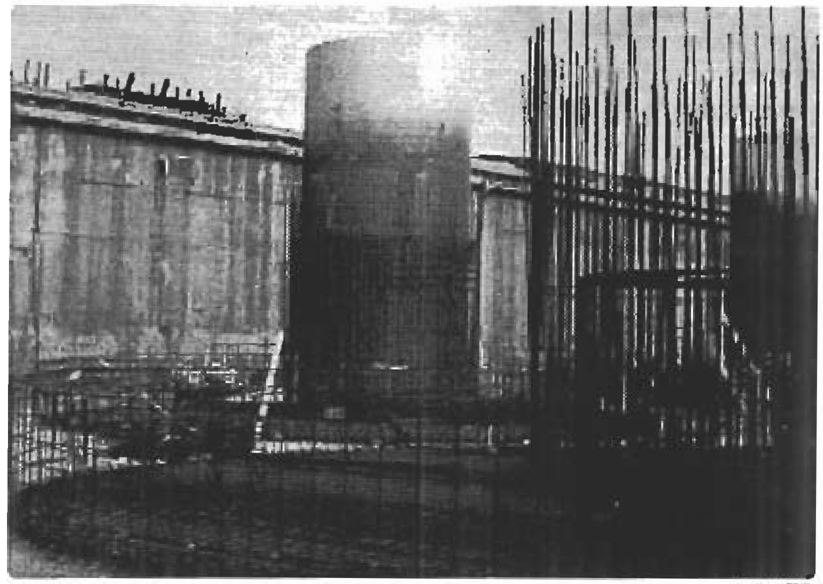
Above the dock, behind the workmen huts, bars are cut and tied together into special shapes, then lowered and fixed to the rest of the steel reinforcement.

In the foreground of the large photograph to the left, two workers can be seen tying up the circular bottom net, and just behind them a finished so-called "trough" is placed on the net.

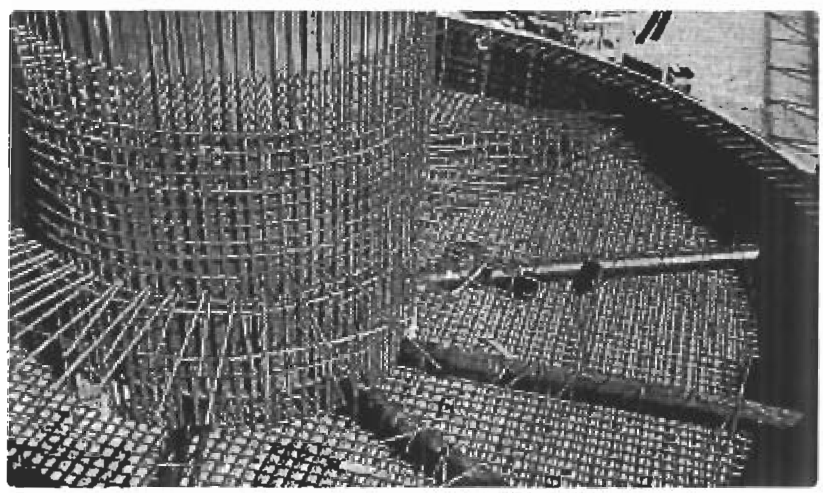
On the right we can see that the trough is fastened to the bottom net. A vertical circular net is tied, forming a "wall" in the foundation's base plate.

A crane then lowers a large tube into the trough. This cylindrical pipe is equipped with boltholes for the wind turbine tower at one end and spikes at the other end ensuring a good connection with the trough.

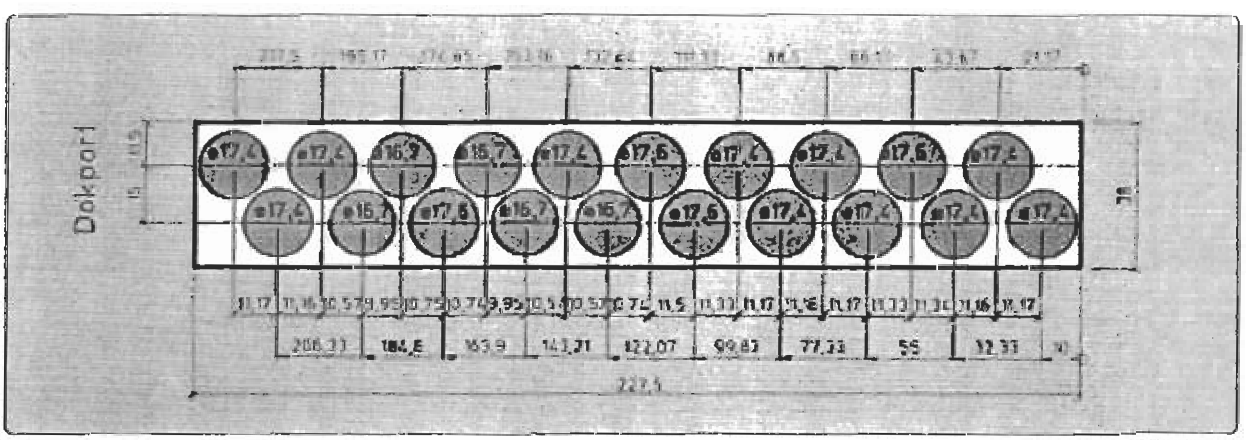
Finally, vertical concrete boarding is placed around the base plate net construction, and the top net of the base plate is lowered down and fastened. Everything is now ready for concreting.



Base plate steel reinforcements. At the back, the central steel tube is mounted into the through



Base plate steel reinforcement with concrete boarding and PVC-tubes for cables (Turbine No. 10)



Plan for foundation layout in the dock

PUMP AND GUN

Two big red and white trucks drive up to the far side of the dock opposite the travelling cranes.

First a so-called concrete pump. Four solid arms with supporting legs shoot out. A big, red arm rises from the truck body, turns towards the dock, and a thick elephant-like trunk sways down towards the reinforcement in the foundation base plate.

The second vehicle is a rotating concrete gun containing ready-mixed concrete. It backs up to the pump, and soon a crunching sound indicates that the concrete is on it's way through the pump and down through the trunk.

CONCRETE WORK

A man from the concrete gang steers the whole process with a small chest mounted control panel. He is standing at the other side of the dock, thus having a good view of the pump, crew and the workers down in the dock. In addition to visual contact he is in constant radio contact with both groups.

Down in the dock, a worker holds the trunk, and soon large clumps of concrete splash down and lie like a thick dark-grey pile on the base plate's rust-red steel reinforcement.

AN ACT OF BALANCE

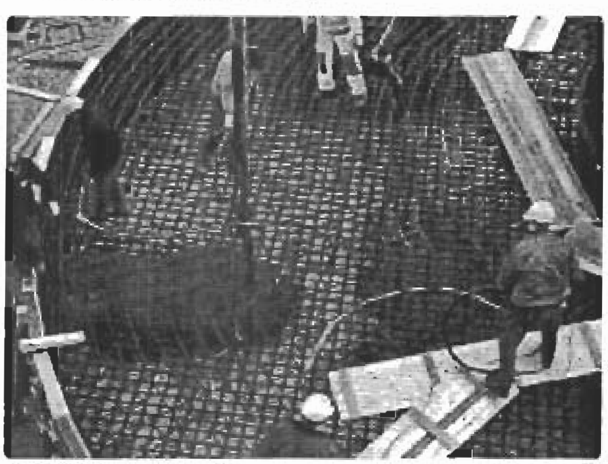
It is hot down in the dock, and the workers take turns steering the mouth of the trunk and spread the concrete. This is not quite so simple. While concentrating on spreading the concrete correctly, one must take care to stand on top of the thin reinforcing steel bars in the top net, where it is easy to lose one's footing.

VIBRATION.

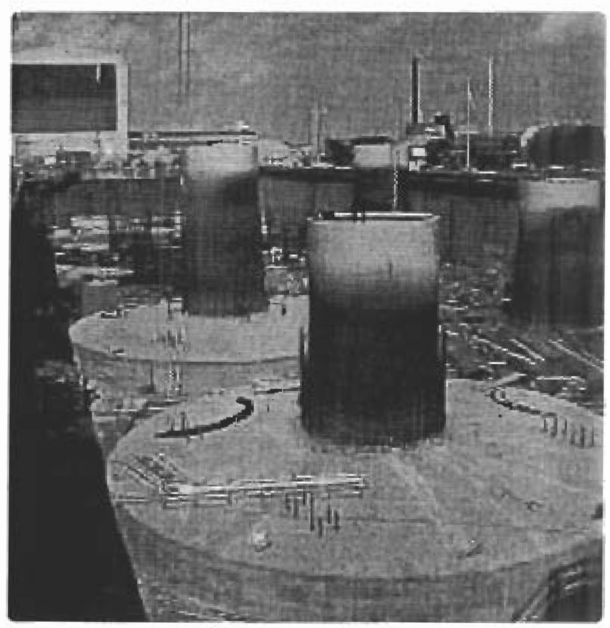
While the concrete is being poured into the base plate, two men follow the worker steering the trunk, sticking long black hoses down into the concrete. At the end of the hose, a long, electrical

A concrete pump in the front of a concrete gun

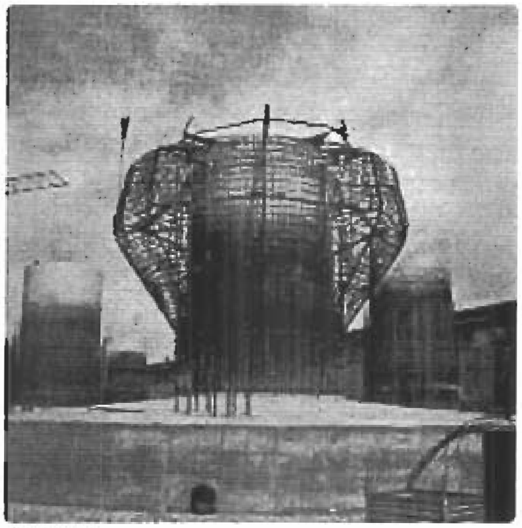
Levelling



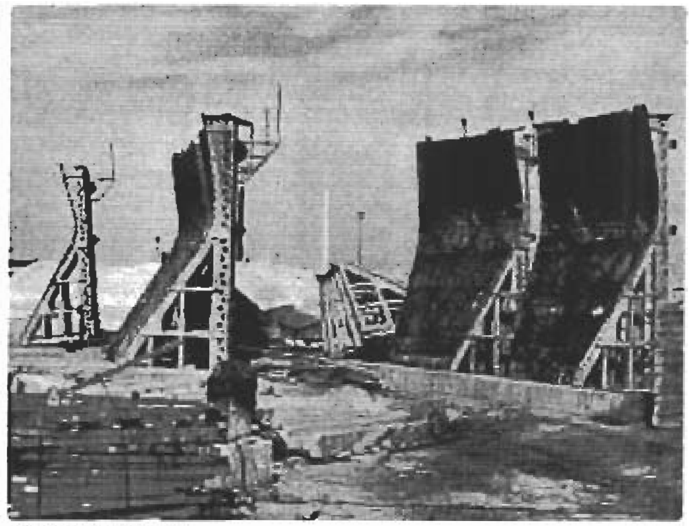
Pouring and vibrating concrete



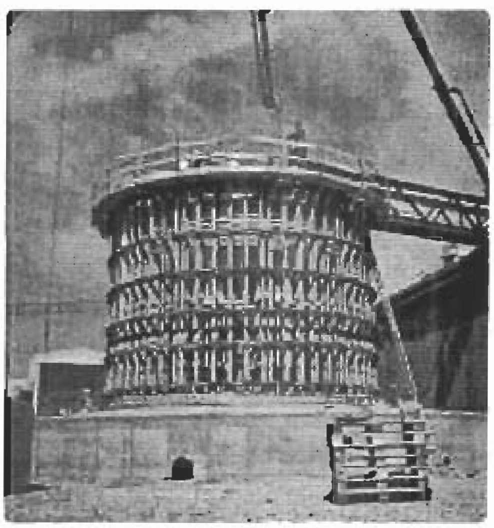
Concrete base plates



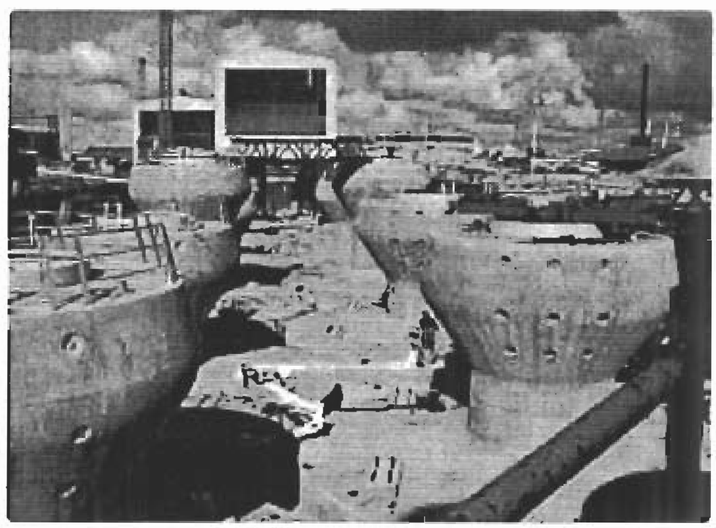
"The tulip"



Concrete boarding units



Concrete boarding is mounted



Concrete work completed

vibrator is situated. Rapid vibrations drive the air bubbles out of the concrete and ensure that it is well consolidated around the reinforcement.

LEVELLING

As the concrete creeps up over the edge of the top net, it is levelled with a straight steel bar placed between the central tube and the outer vertical concrete shutter boarding

To delay premature drying and to ensure optimal hardening of the concrete in the hot weather, water is sprayed over the base plate, and for the same reason the whole base plate is finally covered with black plastic mats to keep it moist.

THE TULIP

In front of the site huts, steel reinforcing bars have been formed into a cone, also called "the tulip". It will act as an icebreaker and as a landing platform for service vessels.

A crane lowers the finished tulip down into the dock, to be tied together with the reinforcement still sticking up from the finished concrete base plate.

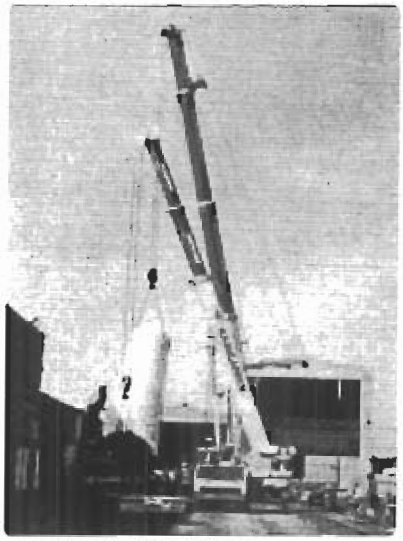
CONCRETE SHUTTER BOARDING

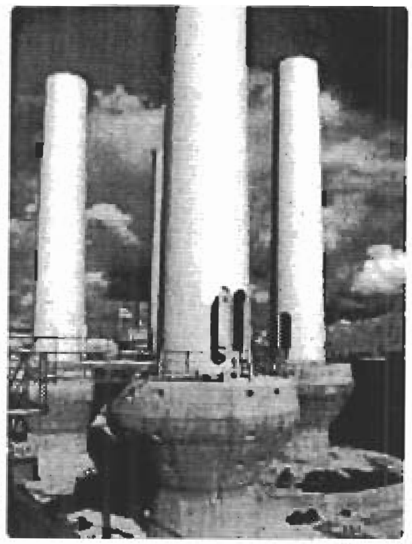
Work now changes character and wooden concrete shutter boarding takes over. Artistically shaped formwork elements are lowered into the dock to be joined together to one large boarding structure, surrounding the tulip. Later, the gangways are made, connecting the construction to the side of the dock. We are all ready for another pouring.

FINAL POURING

Once again concrete is pumped into the dock. First the tulip itself is filled, then the central steel tubular pipe is filled with ballast concrete, packing the PVC tubes, through which the wind turbine sea cables will be connected to the transformer.

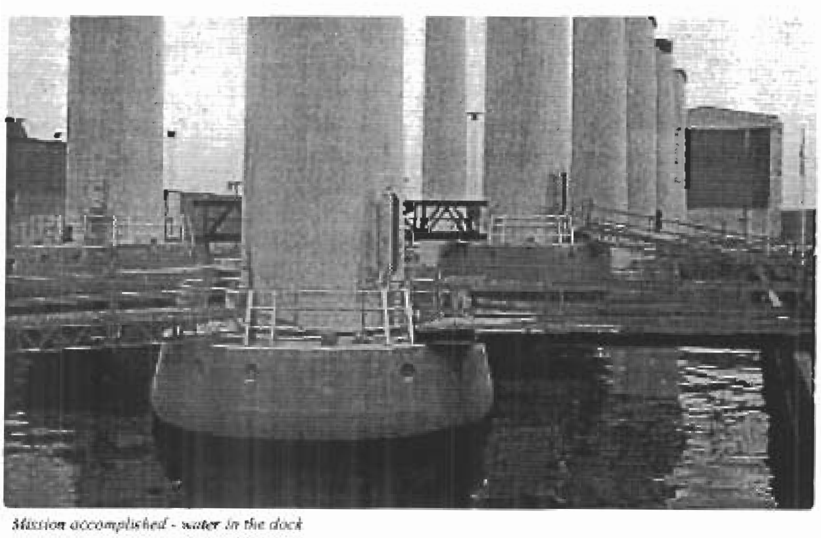
During every pouring, a new concrete gnn pulls up, as soon as the pump is empty. We often see several concrete guns swaying over the dock, all active at the same time.





Assembling of tower base section

The pumping station operator lets the water of Øresund into the dock



Mission accomplished - water in the dock

ASSEMBLY OF THE TOWER BASE SECTION

A large truck pulls up with the tower base section for the Bonus 2 MW wind turbine. The blue overalls and white hard hats of the Bonus fitters are present.

A large and a small crane from the Krangården crane hire firm are also in place, ready to go. The two crews exchange hearty greetings, knowing each other well from many previous installation jobs.

The diesel engines roar, and the hooks are lowered. The cabinet for the electrical system and the transformer are lowered down to the foundation and placed inside the central tube's outer bolt circle, where the bolts for the tower flange are already in place.

The small crane then lifts the bottom of the tower base section, while the large crane lifts the top end. The small crane guides the lower end, thus avoiding possible obstructions on the ground.

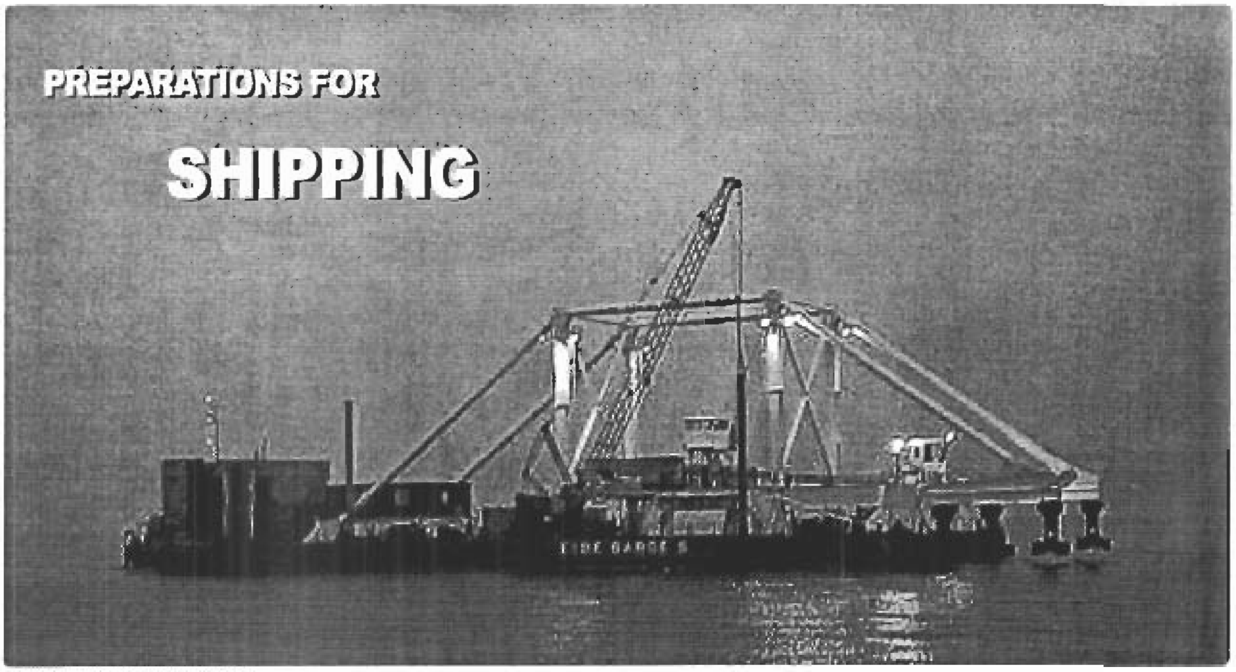
When reaching the vertical position, the hook from the small crane is released, and the large crane swings the section over the foundation, and gently lowers it down to the waiting fitters, who guide it into place over the bolts of the central tube. Soon the metallic hammering from the hydraulic wrenches tells us that the tower section is being bolted to the foundation unit.

THE FILLING OF THE DOCK

Many of us have been looking forward to Monday the 18th of September, when water will finally flood in and fill the dock.

This operation is supervised from a small pumping station at the Øresund end of the dock. Inside the station there is some rather old yellow machinery. However, everything still works fine, and while we all eagerly stand around taking pictures, the water from the Øresund is slowly let in. The dark, green water creeps gently up around the foundations and up the walls of the dock.

After six hours the operation is completed. A vital phase of the project is over - a new one is to begin.



Eide Barge 5 arrives from Norway

Although the dock is full of water, there is still much activity going on. The main priority is the installation of the electrical equipment. Transformers and cabinets for the control units are installed in the tower sections. Teams from Bonus, NKT and Siemens try to finish as much as possible before the foundations are shipped out.

There is much discussion about this future event. Many eyes often look out over the Øresund, until finally on the evening of September 29', the long-awaited vessel "Eide Barge 5" sails through the dusk with lighted lanterns.

THE EIDE

The Eide comes from Norway. She will transport the foundations out to the Middlegrunden and lower them into their positions.

She is a rather strange ship. Below the deck there are 15 large tanks for ballast. They are filled or emptied according to need, and are therefore able to regulate the degree of deflection of the vessel in relation to the horizontal sea level.

The structure above deck is customized for this task, and the large winches, blocks and tackles were previously used during construction of the Øresund Bridge.

On the deck, a white girder construction, shaped like a crane at the front end, will lift and lower the foundations. At the centre of the girder construction the wheel house and a container for tools and storage are built. The container also has a heating oven, a table and some chairs for the workers to use. Abaft, we find living facilities for the six-man crew, and behind them several large concrete blocks function as ballast for the heavy equipment up front.

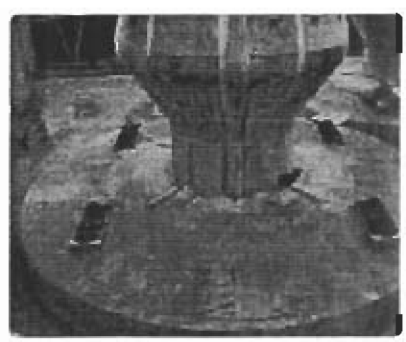
Finally, the vessel has a yellow, mobile crane holding a large, blue iron spear appearing to be able to penetrate down into the seabed, if released.

LIFTING GEAR

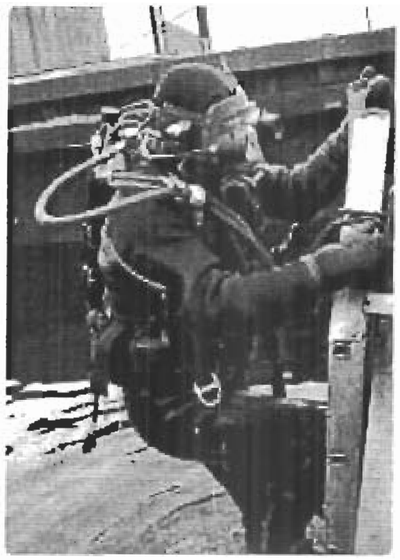
The crane jibs have the shape of two horizontal heavy steel girders. They are shown on the right side of the above photograph. Each girder is equipped with a set of lifting fittings, which are raised and lowered by four hydraulic winches. The wire is operated by a crane driver sitting in a small control cabin just behind the jibs.

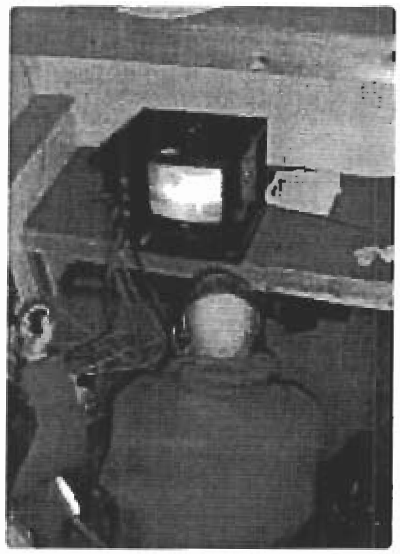
The Eide's lifting fittings will be connected to corresponding fittings fastened to the foundation base plate. Three foundation-sets of these base plate fittings have been made, and as the project progresses they are first mounted and later disassembled by divers.

Eide crane lifting fittings are lowered into the water



Test mounting of lifting fittings on the foundation base plate





The divers at work

THE DIVERS.

We have heard about the divers before, and now we see them for the first time - two divers and a skipper, sailing into the dock with the "Line", a fine old modified tug boat with a yellow cabin and black sides.

The Line sails towards the foundation waiting to be shipped out. She moors at the dockside, while a diver puts on his insulated and close fitting black rubber suit. He is assisted by his mate, another diver, who will remain on board during the operation.

The diver puts on a rubber mask with a built-in microphone and an illumination projector over his head. The mask is connected to a rubber air hose, supplying him with air from a pump on board the Line. An emergency reserve tank with five minutes of air supply is attached to his back.

With a splash the base plate lifting fittings are lowered down into the dock. The diver then sits on Line's railing, falls backwards and a trail of bubbles on the surface indicates his direction.

FASTENING THE BASE PLATE FITTINGS

We go below deck with the diver's mate. He switches on a monitor, so we can clearly see what the diver is doing.

The diver and his mate discuss the task, and the fittings are carefully placed over threaded iron bars sticking up from the concrete base plate. Subsequently, large nuts are tightened with a hydraulic wrench powered by a hydraulic pump on board the Line.

When all four lifting fittings are mounted on the foundation base plate, the diver's mate puts a video tape into a recorder beside the monitor. The diver then films the four lifting fittings, documenting that they are in place and assembled correctly .

Then up to the surface and it is lunchtime.

COUPLING THE FITTINGS

The foundation lies between the Eide's crane jibs, and after lunch the diver jumps in again, and his mate is now joined by a crewmember from the Eide. They both watch the operation from the monitor below deck. The man from the Eide is in radiophone contact with his crane driver.

When the large crane is going to lift the foundation, an outward force will be exerted on each set of the base plate fittings. Accordingly, the diver compensates for this force by fastening a steel wire between the fittings and tightening it with a large yellow tackle.

It is now time for the coupling of the base plate fittings with the fittings from the Line's crane. Each of these fittings is equipped with a mandrel enabling the coupling of corresponding fittings.

The crane fittings are lowered, and on the screen we follow the diver steering the two sets of fittings above each other. The diver and his mate work in cooperation, while the man from the Eide over his radiophone correspondingly instructs the crane driver to raise or lower as necessary. Finally the diver can put the mandrel through the fittings and complete the final coupling.

Within a few hours, all four sets of lifting fittings are coupled, and the diver finally video tapes all sides of the assemblings as proof of the work being done according to the specified requirements.

The Eide with the foundation and the Voe Venture tied alongside

Jens Hansen, SEAS

We board the Eide to see how the foundation is placed on its exact position out on the Middelgrunden.

When we arrive in the morning, the Eide has filled its rear ballast tanks, resulting in the vessel being heavier at the stern and thereby raising the bow. It is therefore well prepared for lifting the 1.500 tonnes foundation waiting ahead.

LIFTING

The crane slowly starts to lift the foundation. This is done by steel wires passing through tackles fastened to the crane jib. They are connected to four large hydraulic winches, placed on both sides of the wheel house. During the lifting process, the ballast is adjusted by filling more water into the tanks.

This operation takes app. one and a half hour until the foundation is finally raised, and the vessel lies in a horizontal position in the water.

Before the foundation can leave the dock, the divers once again come in with the Line. They make an underside inspection in order to check whether any unwanted jagged concrete edges remain from the pouring. If there are, they are removed with a hydraulic pick-hammer.

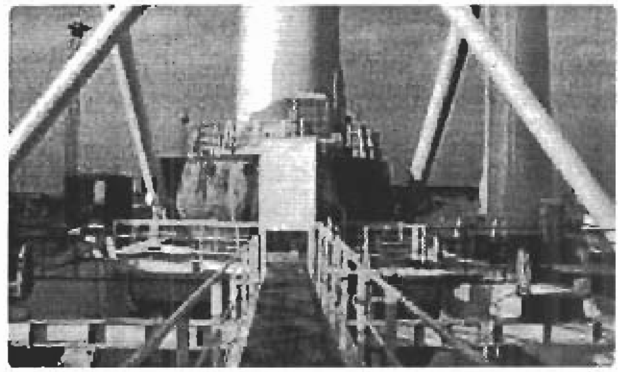
SHIPPING

We leave at 10:30 a.m. The Eide can only sail slowly, and she is assisted by the English work-boat the "Voe Venture", which is tied alongside. The speed is then 3.8 knots.

While crossing the large ship navigation channel Kongedybet, the Eide steers towards the Middelgrund Fort. Half an hour later we are at the northern end of the future wind turbine array. We turn to starboard and sail south into the Hollænderdybet, another large ship navigation channel.

Shipping - the Middelgrund Fort ahead

The Eides' wheel house with crane-winches, two at each side



Catwalk from the wheel house to the cabin of the crane driver

All wind turbine positions are now to our west, towards Copenhagen. When occasionally a sunbeam breaks through the grey and misty weather, we can clearly see the silhouettes of the Copenhagen Town Hall, the Marmor Church and the Amagerværket, which is the utility power station to receive the power from the wind turbines.

10 minutes later, we are now off the position where we shall lower and place the foundation. It is time to leave the Hollænderdybet. The Voe Venture changes her position and now at a right angle, off our side, pushes us towards the target through the recently excavated navigation channel.

GPS-NAVIGATION.

Navigation during the passage towards the exact position is done by the Global Positioning System (GPS), a satellite-based navigation system, whereby a special receiver picks up simultaneously transmitted signals from several satellites in pre-registered orbits. By measuring the time difference between the different received radio pulses, an exact position on the surface of the earth can be computed.

Two independent GPS systems, each with two receivers are installed on the Eide. In addition this system is linked to two receivers on top of the Amagerværket. All these systems working in unison enable the foundation to be positioned with an accuracy equivalent to a circle with a radius of 25 centimetres.

The foundation site coordinates are encoded into the Eides navigation computer. All navigation is carried out in the wheel house, where a surveyor follows the situation on one of the two GPS monitors, and the skipper navigates with the other.

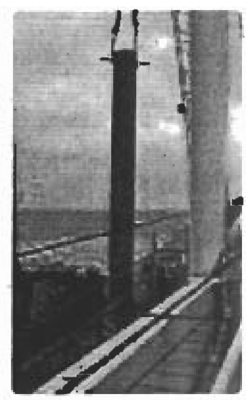
The display is simple. The centre of the crushed stone cushion layer is marked with a cross, and the foundation is shown as a small circle with a tail indicating the navigation route. Slowly, just like a computer game, the skipper now navigates the foundation to its final position via his monitor.

ANCHORING.

After 30 minutes, the skipper has navigated the unit to a position two metres from its final position. The mandrel holding the blue spear in place by the auxiliary crane is removed, and it plunges down into the seabed. Eide is now securely held.

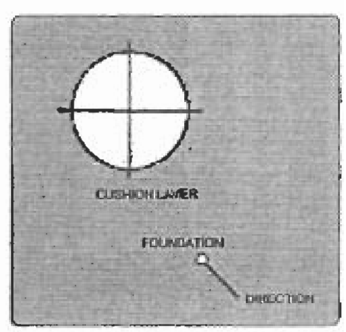
The Voe Venture sails to the opposite corner and lifts an anchor, fastened to a wire joined to a deck winch on board the Eide. The Voe Venture then sails out app.100 metres and lets go. This process is repeated until four anchors are finally laid out, each attached to a winch at all four corners of the Eide.

The Voe Venture handling an anchor



The spear of Eide

Winch for anchor wire



GPS - simplified screen image

POSITIONING

Now that the Eide is securely anchored, the auxiliary crane hoists the blue spear up from the seabed.

Using the GPS and the anchor connected corner winches on the barge, the skipper now steers the unit towards the target area. He controls the front hydraulic winches and is in radio contact with the crew members operating the two rear motor driven winches.

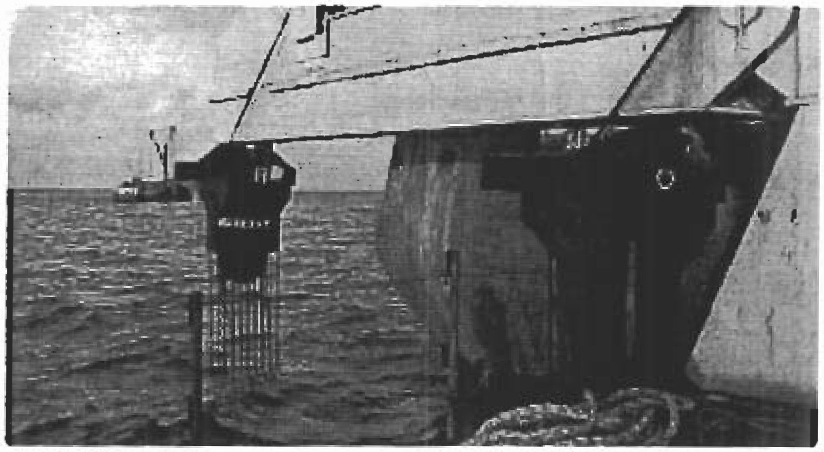
When the foundation is exactly above the target, the large winches on each side of the control cabin, equipped with strain gauges to avoid overload, gently lower the foundation down towards the bottom.

Approximately 30 centimetres above the crushed stone cushion layer, the crane stops the descent. A diver is sent down to check the position of the foundation and its angle in relation to the horizontal level of the cushion layer. Necessary adjustments are made by the crane winches so that the bottom of the base plate is parallel to the plane of the cushion layer surface. When this is satisfactory, the foundation is gently positioned on the cushion layer.

The foundation weighs 1.500 tonnes. However, during the initial lowering phase a crane wire backs-stop is applied, and the foundation is placed on the cushion layer with a weight of only 300 tonnes. It is now finally in place and will not settle further. The time is now 2:30 p.m.

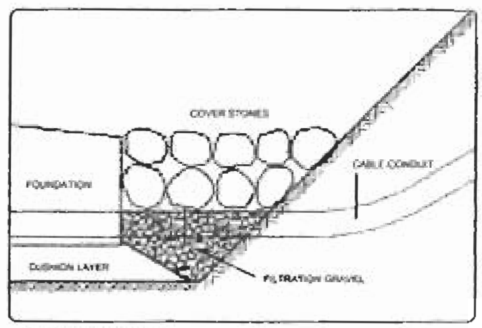
CONTROL

The deviation degree of the tower base section is checked by a large water level and long aluminium rails fastened at the bottom of the tower section. The deviation should not exceed 0.25 degrees. However, should this be the case, special shims must be fabricated, to be placed under the tower bolt flange, when the Bonus fitters and the crane crew install the upper sections of the wind turbine. Luckily, there is no need for these extra shims, and all 20 foundations are placed in the correct vertical position.



Lowering of the foundation

Diver going down for control



Construction details

FINAL POSITIONING

After the vertical deviation has been checked, the positioning of the foundation continues.

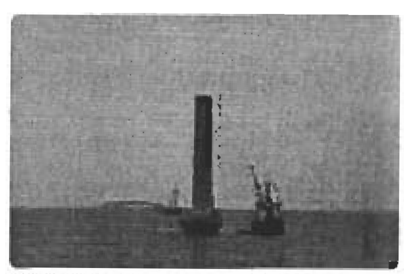
During the sea transit, the Eide's rear ballast tanks has been filled to compensate for the weight of the foundation. As the load strain on the crane is now reduced, the water in the tanks is emptied to return the vessel to a level position. This is a two hour process.

As the foundation now rests on the cushion layer, the diver goes down again to disengage the lifting fittings and load them back on the Line. This process alone takes a few hours. He then checks if there is any hollow spaces between the surface of the cushion layer and the bottom of the foundation bed plate (caused by the former vibration). He measures the periphery, and these measurements are registered on a tape in the Line's video recorder.

FINISHING WORK

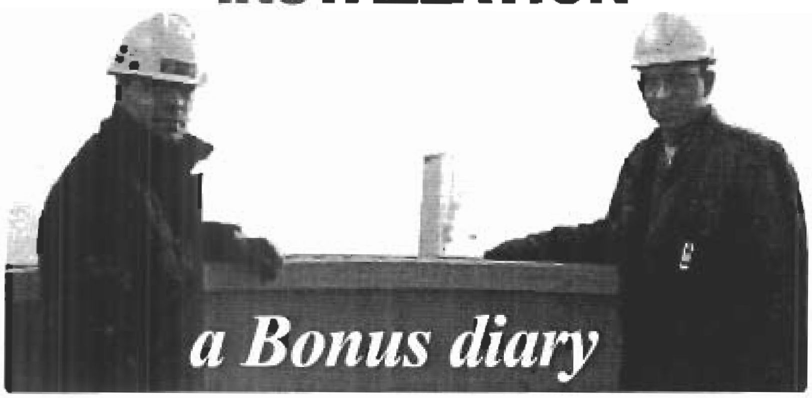
Subsequently, divers will inject stiff black hydraulic cement into these hollow spaces,ensuring that in the future the crushed stone cushion will remain intact and continue to fully support the foundation.

A cable-conduit will be fastened onto a pipe-junction sticking out from the side of the foundation base plate. This arrangement will later be used by the company NKT Cables when connecting the sea cable to the transformer inside the tower base section. Finally, a construction vessel will return to the site and fill the trench alongside the base plate with cover stones and filtration gravel.



A construction vessel places cover stones

WIND TURBINE INSTALLATION



It took just under two months for Bonus to install the 20 wind turbines on the Middelgrunden. Now follows the story of the most important events on land and at sea.

23 October:

PREPARATION OF THE BASE

The autumn weather is dark and damp, when we meet to establish a base for assembly and installation preparations. The chosen site is the old B&W quay for fitting out on Refshaleoen. We are seven persons, five fitters and two site managers.

Along one side of the site two workmen site-huts are installed, one to be used as an office and one for the fitters. We also install a container well equipped with tools and fittings.

Colleagues from other companies, for instance Krangården, NKT Cables and KK Electronic, are also moving in. App. 13-14 site-huts are connected by wooden gangways with layers of thick, brown mud. During the next couple of months, about 60-70 workers will be based here.

On the site, our white truck waits with the "Elephant-foot", a stand for assembly of the rotor. This is unloaded and placed app. 15-20 metres from the quayside, near a 360 tonnes crane from the Krangarden.

THE THIR

Tied up alongside the quay lies the Thir, a big black barge from Svitzer. She has been there since August. On board a 180 tonnes crane is installed, and another elephant-foot identical to ours on shore. In addition fittings for secure tranport of the upper tower section and the nacelle of the 2 MW Bonus wind turbine have been mounted. Also, a couple of yellow metal huts for the crew have been arranged. The Krangarden has run this entire operation.

26 October:

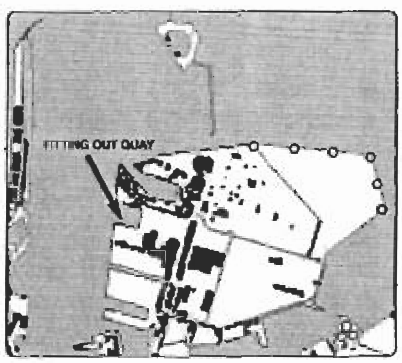
THE MUHIBBAH

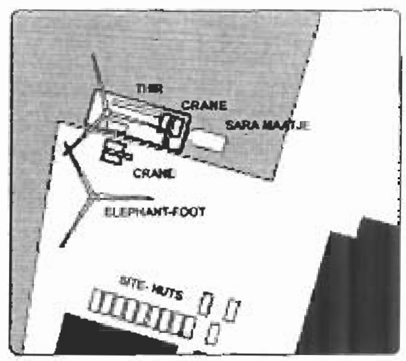
Installation of the base proceeds according to plan, and we have time to stand on the quay and watch the tug boats the Sara Maatje and the Orion haul the Muhibbah into the harbour.

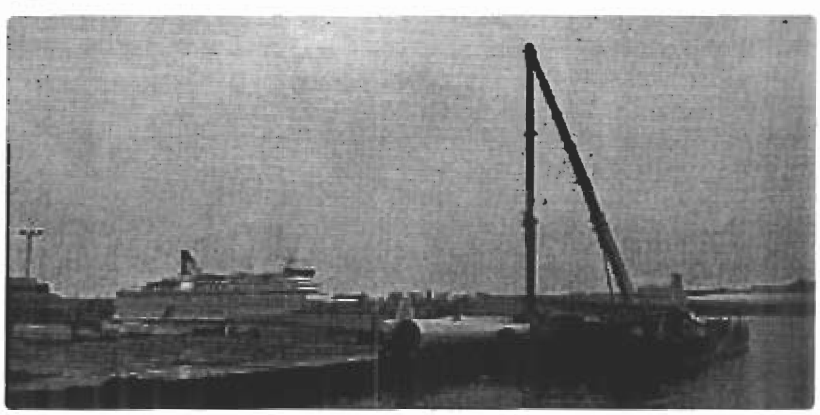
The Muhibbah is a jack-up crane, and despite of the oriental sounding name she comes from Rostock in the former German Democratic Republic, where she was built in 1960.

She is black and huge, carrying a large orange 550 tonnes deck crane and a white building with the technical systems and bunks for the crew of seven men. However, the general impression is of a slightly rusty vessel.

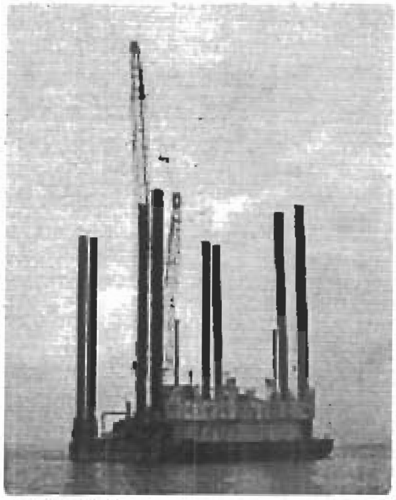
A set of long legs sticks up in each corner, eight hrown legs in all. During the tow, the legs are supported and held up by large air bags. When the vessel finally arrives at the site, air is released from the bags, and the legs slam to the seabed under their own weight making a tremendous noise.



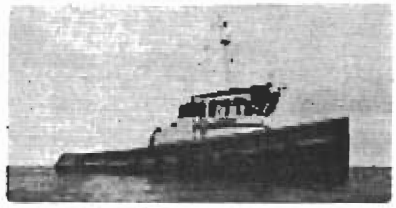




The Bonus base at Refshaleoen. Thir and cranes at the right



The Muhibbah



The Orion

The Sara Maatje

When hydraulic pressure is applied to the legs, they can lift the vessel free of a rough surface. This process is called "jacking-up", hence the name.

The three vessels all come from a job in Scotland and the trip should have taken them app. 12 days. However, rough seas and a zig-zag course, necessitated seeking shelter during the voyage to Copenhagen, and resulted in a total voyage of 27 days.

27 October:

We are now ready to install the first wind turbine, but all Muhibbah's equipment is lying about on the deck and must first be put in order. Supplies and diesel fuel must be loaded, and the required meetings to discuss various safety operational procedures must be held. Equipment for measuring wind speed must be installed and finally the vessel must be classified and certified by Germanischer Lloyd.

29 October:

SAFETY REGULATIONS

Finally, everything is prepared for wind turbine installation, and on the fitting out quay, everybody is eager to get started. Unfortunately, the wind is now so strong that the safety regulations and requirements cannot be met for several days. The fitters return to other tasks in Jutland, remaining on stand-by for the Middelgrunden.

As for safety and insurance, the following requirements must be observed:

1) All marine activities and tasks must be led and coordinated by an appointed "Tow Master".

2) The Muhibbah and the Thir must not be towed nor positioned, if the wind speed exceeds 10 m/s (measured at 10 meters above sea-level), if the water current at the position exceeds 0.5 knots, or if the wave height at the position exceeds 0.5 metres. In addition, there must be 1 nautical mile (1.8 km) minimum visibility.

3) The rotor must not be lifted if the wind speed exceeds 10 m/s at a height of 60 metres above sea level.

4) Wind turbine work must not be done when the wind speed exceeds 18 m/s.

5) All "first-time" operations must be carried out during the hours of daylight and under more favourable weather conditions than those described above.

2 November:

PERMANENT CREWS

We are now back in the capital, this time with nine fitters: A permanent shore crew of four men and a permanent sea crew of five men.

In cooperation with the team from Krangården, the shore crew assembles the rotor on the moorage and loads it on board the Thir together with the upper tower section and the nacelle.

Together with four to five people from Krangården, the sea crew installs the wind turbines out on the Øresund. As the project proceeds, fitters who will carry out further start-up work on the installed wind turbines will supplement the sea crew. The start-up work ensures operational readiness of the turbines.

The installation of all 20 wind turbines is expected to take app. two months. During this period, the crews will not often see their families at home. However, they know what is expected and have all given each other their word to finish the job.

Firstly, everybody stays in single rooms at a hotel in the Copenhagen suburb of Brøndby, but after a couple of days everyone moves to the First Class Dan Hotel in Kastrup. This is at no further cost, with less time spent on the highway and the possibility for very early breakfasts, which later proves to be an important factor.

The hotel lies near the airport. The blue overalls of the Bonus fitters crossing the lobby form a great contrast to the elegantly dressed businessmen.

3 November:

LOADING THE THIR

Once again a cold and damp morning, and it is finally time to load the Thir.

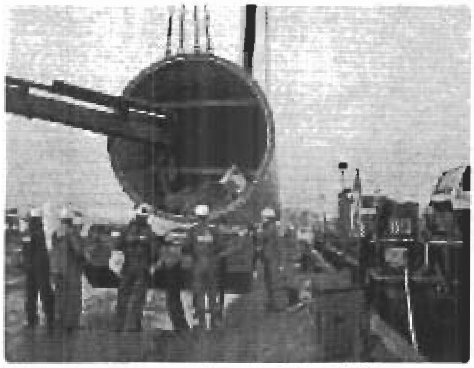
Out of the dark, up at the northern end of the base, powerful truck lights are switched on, and a big red transport trailer with wind turbine main components starts to move forward through the dark mist.

The quay is lit up by powerful floodlights, and the upper tower section is driven forward for unloading. The two Krangården cranes, one on the moorage and one on the vessel, lift the tower section at each end and swing it onto the deck, where it is secured with circle shaped fittings.

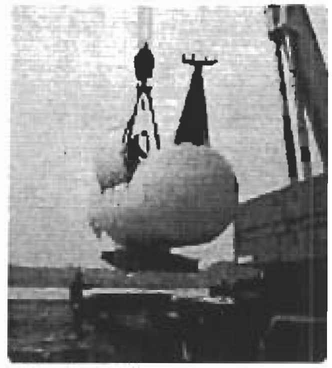
The nacelle is then lifted on board by the crane mounted at the Thir, and it is secured with big yellow tackle chains.

From now on, the Thir is often on the way to the Middelgrunden with components, when the transport trailers drive in. Subsequently, the wind turbine components are then loaded onto racks on the moorage and are later lifted on board.

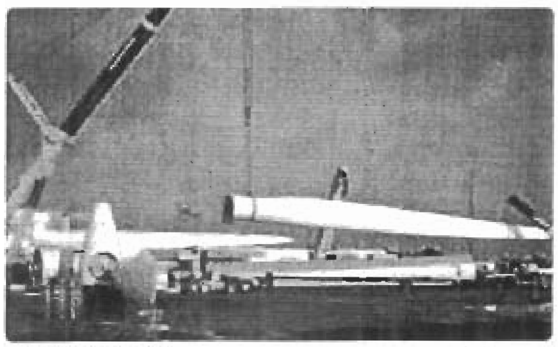
While the nacelle is being loaded, the hub is driven in, unloaded and fastened on the elephant-foot.



The upper tower section is being loaded onto theThir



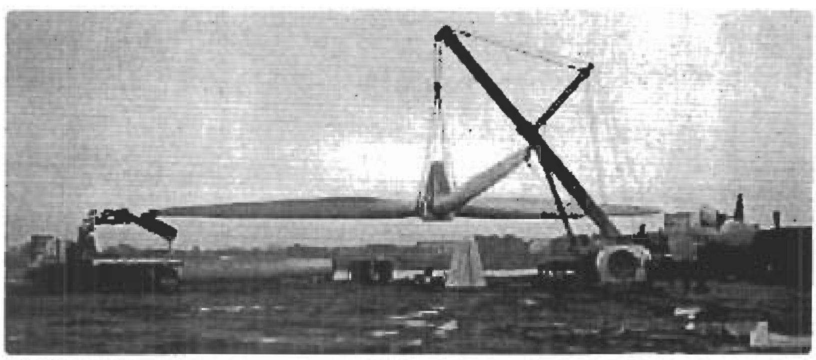
Lifting the nacelle



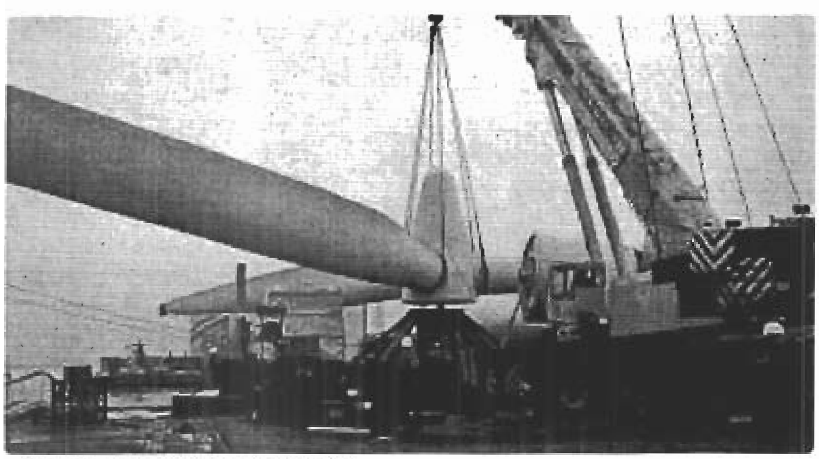
Mounting of the rotor

Jens Hansen, SEAS

Jens controls truck crane



The Rotor is being lifted on board the Thir



The rotor is lowered onto the Thir's elefant-foot

Trucks, extended as far as possible pull up to the site carrying the blades. One blade at each trailer. "How big everything has become now" we think, as we move backwards to find a distance enabling us to have the entire blade in our camera window.

For a short moment the sun breaks through the clouds, and the glass fibre blades turn increasingly white in the sun. The moorage crane lifts the blade root while our truck mounted crane lifts the blade tip.

Over by the hub, in radio contact with the crane from Krangarden, Jens very concentrated operates the truck crane with a chest mounted control panel, steering the blade tip free of any possible obstructions.

The two cranes lift and move the blade from the trailer towards the waiting hub, where the root bolts are carefully guided through the hub bolt-holes.

Two fitters crawl into the hub, and soon the typical metallic clicking from the hydraulic wrenches tightening the hub bolts is heard.

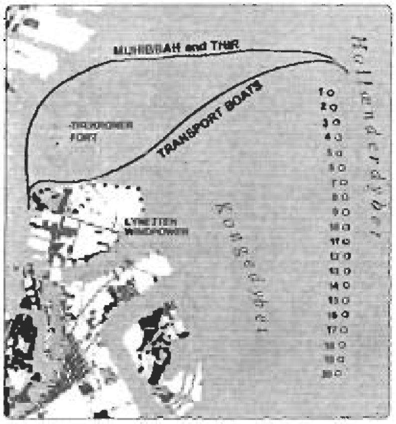
When all three blades are tightly bolted to the hub, the moorage crane moves the lifting straps from the blade root to the hub lifting fittings. While Jens steers the blade tip with the truck crane, the moorage crane now gently lifts the rotor and lowers it down to be fastened onto the elephant-foot on deck.

THE MUHIBBAH SETS OUT

While the Thir is being loaded, the Muhibbah leaves the quay at 10:15 a.m., towed out into the Øresund by the Sara Maatje and the Orion.

The Muhibbah and the Thir are always towed to the north of the Trekroner Fort and leave the harbour area from there. The smaller transport boats with the crews and smaller components sail south of Trekroner and out through Lynetteløbet.

Just past midday the Muhibbah runs into heavy currents, and as the vessel cannot exceed a speed of 3 knots, and in order to be at the first site on time, assistance is required from the Goliath, a larger and more powerful tug boat.



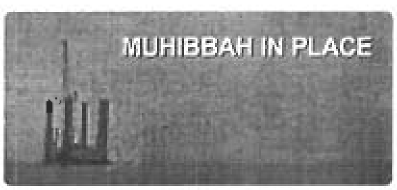
Shipping routes and wind turbine sites


Sara Maatje pushes Thir

THE MIDDELGRUNDEN

The plan is first to install wind turbines Nos. 12-20 at the southern end of the array, and yesterday Orion left to check the navigation channel route for site Nos. 12 and 13.

The Middelgrunden is bounded by the navigation channels the Kongedybet to the west and the Hollænderdybet to the east. As the sea in front of the wind turbines towards Copenhagen is rather shallow with water depths of 2.5-5 meters, all passages to the wind turbines must go through the Hollænderdybet. The passage to this point always goes north of the wind turbine array.



It is now 2:30 p.m. and the Muhibbah at the site of wind turbine No. 12. The Tow Master leads the operation from the deck with his radiophone, ordering the Orion and the Sara Maatje to pull or push the jack-up crane, manoeuvring it into its correct position. At 3:15 p.m. everything is in place and the legs go down into the seabed.

The Mubibbah has brought a mobile gangway enabling the fitters to walk over to the foundation. When attempting to lift the gangway into its position, we find that we are situated five metres short. However, the Muhibbah will remain in place, as the crane jib has enough reach and the fitters can sail to the foundation.

4 November:

THE THIR LEAVES

At 7:10 a.m. the Thir is pushed out of the harbour by Sara Maatje with the Orion alongside, carrying the components for wind turbine No.12.

Near the Muhibbah, the Thir is pushed up along the side by the Sara Maatje. Then the Orion pushes her in close to Muhibbah. Again, the Tow Master runs this operation, and at 8:30 a.m Thir is positioned at site No. 12.

1st ERECTION (Turbine No. 12)

Almost at the same time a group of nine people from the Bonus sea crew and the Krangården crew leave on board the light transport vessel the "Skagerrak". It has room for 20 passengers. A similar boat, the "Ålesund", has also been chartered by Bonus. These boats, with a crew of two men, provide rapid and flexible transportation of personnel and equipment between the Middelgrunden and the shore base.

Out of the harbour, we turn to the right and pass the Lynetten sewage disposal plant. From the grey quays the seven Bonus 600 kW wind turbines, commissioned in 1996, greet us as we sail by. After a 15 minute run we lie alongside the Thir and climb on board.

The cranes on the Thir and the Muhibbah start up, and we hear the ghastly coughing from Muhibbah's robust old American engine.


Skagerrak - the top right picture shows Ålesund

Two fitters sail to the foundation, and the Thir crane lifts a diesel generator over to power the hydraulic wrenches that the fitters will use to bolt the different components together.

They climb up into the tower base section already installed on the foundation and remove the aluminium covers preventing water and dirt from penetrating. The Muhibbah crane lowers them down onto the Thir's deck.

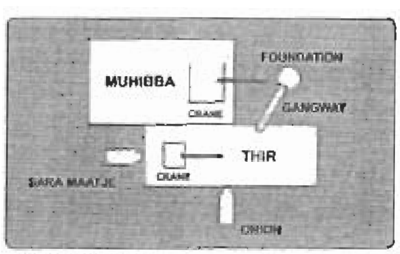
TOWER ERECTION

On the deck, the upper tower section is released from the transport fittings. The hook from the Thir's crane is fastened to lift the fittings fastened to the bottom flange, while the Muhibbah crane "grabs" the lifting fittings in the top flange.

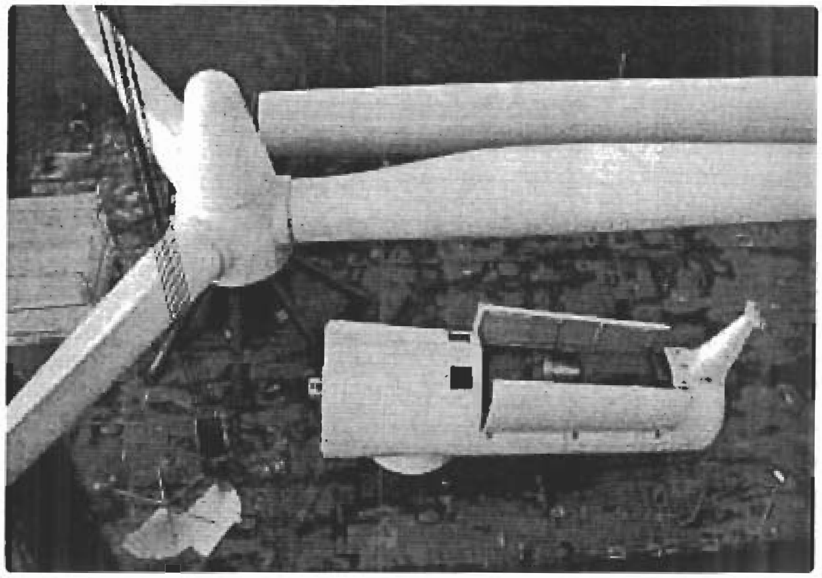
Muhibbah's crane lifts the tower upwards, while the smaller crane on the Thir steers the base free of the different hindrances. We are in radio contact with one of our men in Muhibbah's crane cabin, translating the different instructions to the German crane driver.

At 10:10 a.m. the large tower section is hanging straight down one and a half metre above the deck, and the lifting fittings at the tower base are released. A man in an orange overall from the Krangarden team loosens the hook, while the crews from Bonus and Krangården help each other to remove the fittings from the tower base flange. Sometimes they must stride over big, thick grey aluminium cables sticking out from the tower base, lined out in two long rows on the deck

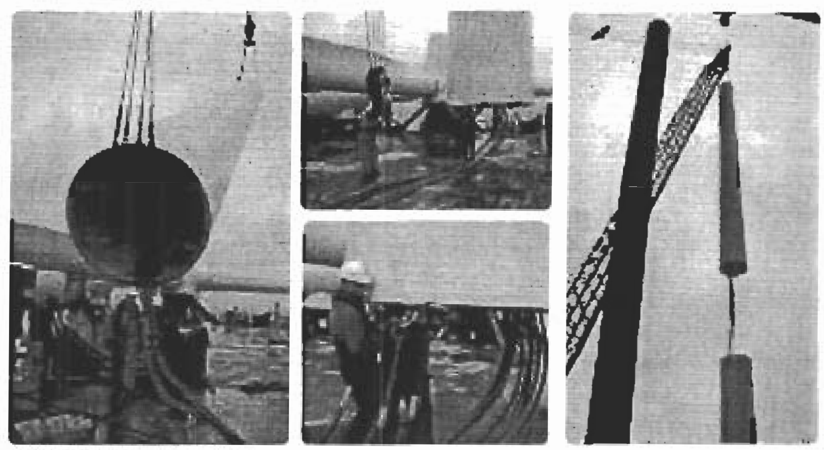
The Muhibbah engine coughing is heard again, and the big crane lifts the tower section up into the air with the aluminium cables hanging down like a long dark line from the bottom.



Position of vessels



Wind turbine components on board the Thir



The upper tower section goes up

The tower is turned towards the fitters, who can be seen as two small spots at the top of the base tower section. They catch hold of the cables, and while the upper section is slowly lowered, the cables are led down towards the control cabinets below.

The two tower sections are now almost connected. The fitters are in radio contact with the crane driver steering the flange into its right position. Soon two bolts can be fitted through the flange bolt holes, and the crane slightly slackens the lift. At 11:00 a.m., the remaining bolts are placed and tightened The tower section is finally assembled, and the crane releases its hold.

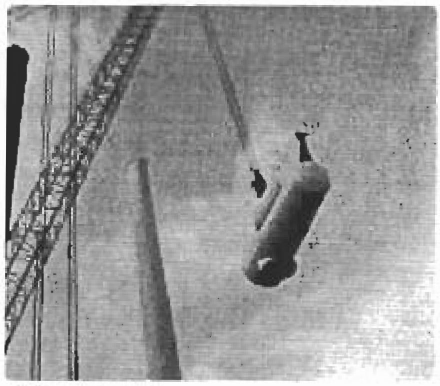
NACELLE LIFT

The Muhibbah crane-hook is now lowered down over the nacelle, and two fitters climb into it by a ladder and attach the hook to the nacelle lifting fitting.

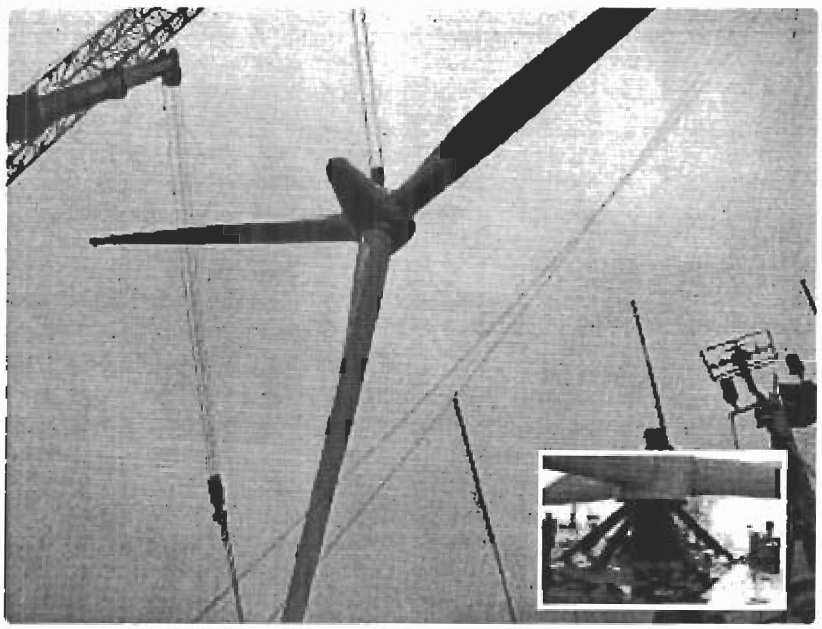
DRAMA

A dramatic event arises when a wave from a passing tanker suddenly causes Thir to sink a metre. The pull on the nacelle thereby changes from the expected 40 tonnes to 100 tonnes, overloading a shackle tying the nacelle down to the deck. From now on, all tie-downs are released before attachment of the crane hook, and a good lookout is kept for possible disturbances from waves.

The nacelle is being prepared for lifting



The nacelle goes up



Up goes the rotor, the Elefant-foot at the right

At 11:30 a.m.we hook up again, and up goes the nacelle. At 1:30 p.m. San unexpected rapid yawing of the crane causes some problems, however we are very careful, and the nacelle is finally in place.

The rotor is loosened from the elephant-foot and prepared for erection, but Muhibbah's crew refuses to do any further lifting today. Therefore, we sail back to the Refshaløen, leaving Thir with the rotor at site No. 12.

NEW POSITION

The yaw problems with the Muhibbah crane result in excessive side-to-side swinging of the rotor during lift. We therefore decide that during the ongoing and future lift operations the Muhibbah must remain at its present position, at a distance comparatively far away from the foundation. This will then allow the rotor to be mounted more "directly" on the nacelle.

5 November:

ROTOR LIFT

At 7:00 a.m. we board the Skagerrak for further installation of turbine No. 12. The Thir is still there, rotor on deck. On arrival the cranes start up, and two fitters connect Muhibbah's crane hook to the yellow lifting fittings on the hub, while below, the bolts fastening the rotor to the elephant-foot on Thir's deck are removed.

At 9:00 a.m. the Muhibbah lifts the rotor, while the Thir's crane is attached to the blade tip pointing downwards, thereby steering the rotor free of possible obstructions on the deck. Up it goes, and the smaller crane releases its grip on the bottom blade tip. The two blade tips facing upwards are steered from side-to-side with blade ropes. Fitters placed on both the Thir's and the Muhibbah's deck control the ropes.

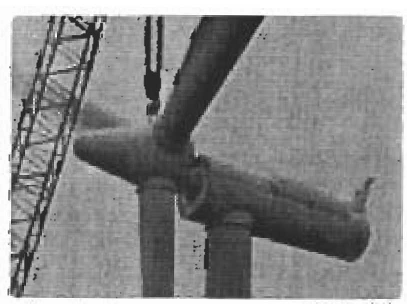
BEGINNER DIFFICULTIES

When the rotor reaches the nacelle, it is hanging oblique, making it impossible to mount it onto the main shaft. Therefore, it must be re-lowered and bolted to the elephant-foot once again.

This is not surprising as we are working with a new, large wind-turbine type, which in addition will be erected at sea for the first time.

The problem is solved on the deck. The hub lifting fittings are moved, and the cut on the spinner is modified. After three hours of work the rotor goes up again. This time it is hanging better, but it still calls for experienced fitters to position it. At last we succeed, and the hub bolts are tightened. The first wind turbine is installed.

Mounting of the crane hook on the hub lifting fittings



Almost there!

Jens Hansen, SEAS

ADJUSTMENTS

Eventually, additional alterations of the lifting fittings and another four-five rotor lifts are necessary, before we are completely satisfied.

It should also be mentioned that in the beginning we have some problems with the blade ropes. At sea there is not quite the same space as on shore, and therefore the angle up to the blade tips becomes rather steep. This asks for a stronger pull in the ropes, and often the fitters have to wind them round a pipe in order to keep the rotor under control.

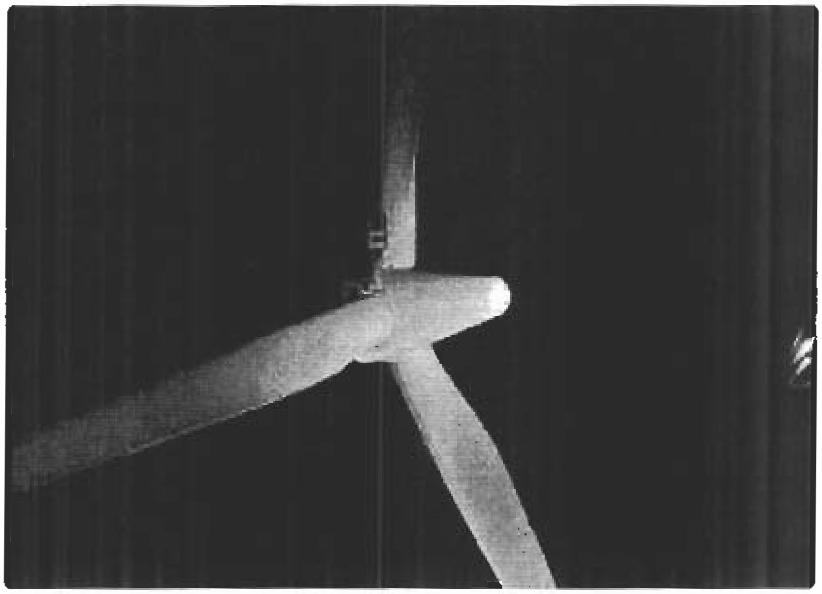
We start by using a new type of blade rope with ultimate stress. However, they soon show signs of poor wear resistance, and we quickly require 800 metres of the old type of blue nylon "farmer's rope" from the factory in Brande. These give satisfactory service for the rest of the project.

BURSTED AIR-HOSES

This afternoon we are warned of our future relationship with Muhibbah.

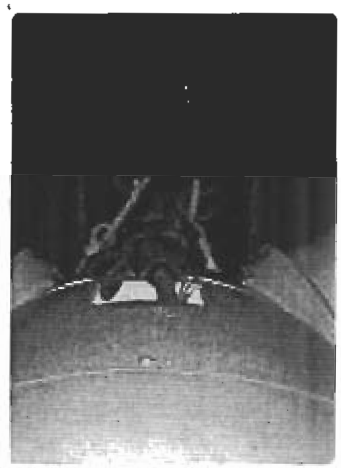
Now that wind turbine No. 12 is installed, the jack-up crane will be towed to position No. 13, the next installation site. However, two of the leg air-hoses burst, resulting in an extra three hour wait.

At 9:14 p.m. the Muhibbah is ready to be towed again. At 11:16 p.m the legs are finally set down on the Øresund seabed, and the jack-up crane is in position once again.



The rotor goes up

The rotor by the nacelle



65 metre above Øresund at night

Air-hoses around the Muhibbah's leg

6 November:

START-UP WORK

Today, the wind blows 14-20 m/s at 60 metres height. This is too much, so we can forget about wind turbine erection. The time is spent clearing up and starting up the work in wind turbine No.12.

The start-up work entails tightening all bolts to the correct torque. During the actual wind turbine erection all bolts are tightened "provisionally" in order to install the wind turbine as quickly as possible saving expensive time using the crane .

After the bolts have been correctly tightened, the rotor is allowed to run idling with pitched blades preventing it from a run-away. The purpose of this slow rotation is to protect the transmission bearings from standstill marks, which may appear in case of a longer stationary period before the turbine is connected to the grid. A temporary idling oil pump is installed ensuring adequate gearbox lubrication.

Apart from tightening bolts, the start-up work in this phase also involves removing the lifting fittings and placing the control- and steering cables etc. The start-up work, described in details on page 36, continues as the wind turbines are erected, one by one. This is also done on days when weather conditions are not suitable for safe wind turbine erection.

SEASICKNESS

During start-up work on wind turbine No. 12, the wind speed is 18 m/s for four-five hours. This can be felt inside the wind turbine, and the fitters look rather queasy when they finally get to shore. Even though it doesn't always blow this strongly, everyone suffers from milder seasickness during the first two weeks. When arriving back home at night, our floors and beds are swaying.

7 November:

2nd ERECTION (Turbine No. 13)

There are now 14 fitters from Bonus on the base, and while the crew on shore prepares and loads the main components for turbine No. 13 on board the Thir, the sea crew waits for the weather to improve, as predicted by the weather forecast. In the morning the wind speed is about 15 m/s, but luckily it drops to about 8 m/s in the afternoon.

We finally start installation of turbine No. 13 at 8 p.m., and this evening, like many to come, we work under artificial light. This is not problematic - it is actually a fantastic sight with the big white components all lit up against the dark sky. In the distance the city lights from Copenhagen provide a romantic background.

The erection proceeds well, and we are grateful, that a good routine seems to show:

02:00 p.m.: The Thir leaves with the components

07:00 p.m.: The Bonus and the Krangården crews leave for erection on board the Skagerrak

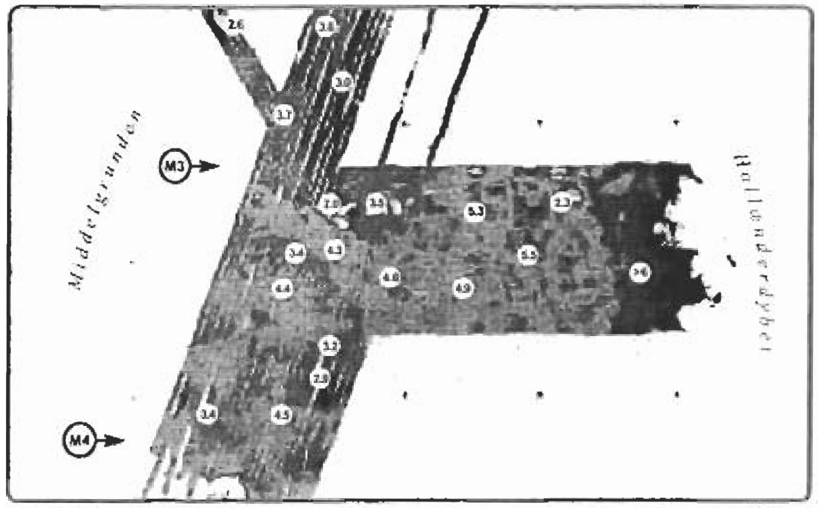
08:00 p.m.: Start of erection

03:30 a.m.: Wind turbine No. 13 erected without serious difficulties

05:15 a.m.: The Thir arrives back at the moorage, ready for a new load

8 November:

The Thir is loaded in the morning, but during the day the weather deteriorates with wind speeds of 10-13 m/s and a current of app. 2.5 knots. A new



Seabed scanning

positioning of the Muhibbah is first postponed and then cancelled.

9 November:

THE MUHIBBAH RUNS AGROUND

The weather conditions are now very close to the maximum permissible safety limits.

The Muhibbah is towed away from wind turbine No. 13. She runs aground trying to get into site No. 14. The sea is not as deep here, as the owners have informed us. After two more attempts, each resulting in a new grounding, we give up, and the Muhibbah is towed back to the harbour for an inspection.

Back at the quay divers conduct a visual inspection. Apparently no damage has been done to the vessel, it is just "a little scraped". The diver inspection notes, that the hull looks healthy enough.

10 November:

ADDITIONAL SEABED INVESTIGATION

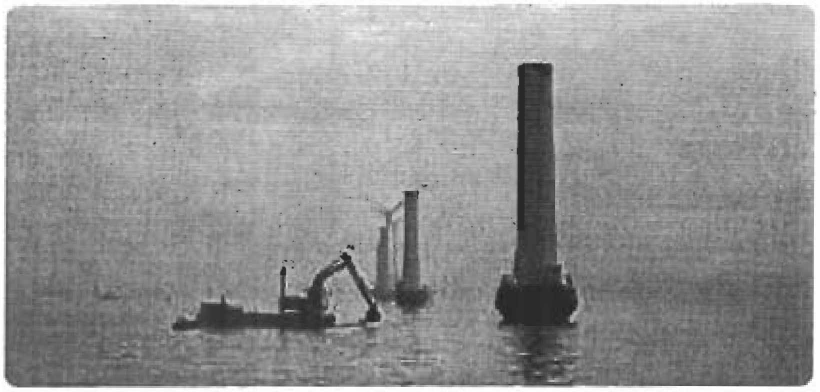
Bad weather with wind speeds of 11-17 m/s.

Additional seabed mapping starting the following morning is now ordered for all passages to the foundations. For this purpose an advanced echo sounder scanning by Svitzer Surveys is made. It is also decided that the Bonus project manager will be on board the Muhibbah during tows between the different sites. He will coordinate the approach to the foundations and decide when divers will have to go down to check the depth in problematic areas. This happens app. seven or eight times during the duration of the project.

OVERHAULING OF THE MUHIBBAH

While in dock, repairs start on the legs, and the cooling water pump needs an overhaul. A lift stop is now installed, preventing the crane hook from hitting the wire pulley at the top of the crane jib. Strangely enough this is not a legal requirement, but it is almost always fitted on shore based cranes.

Muhibbah's crane



A Construction vessel deepens a navigation channel

11-12 November:
It is weekend and still very windy, so all Bonus fitters are off for the weekend.

13 November:
Continously bad weather, now with wind speeds of 12 m/s and a current of 2.6 knots.

20 Bonus fitters are now on the base, working on many different tasks: Unloading components onto the quay, assembling rotors and continuing the start-up work on the two wind turbines erected so far. A few men are working in the B&W dry dock, installing cables in the tower base sections, which are already mounted on the foundations, waiting to leave.

The seabed investigations to determine a safe passage continiue, and today the navigation channels for sites Nos. 6, 7 and 8 will be examined.

INADEQUATE DEPTH

The preliminary results of Svitzer Survey's seabed measurements at sites Nos. 14 and 15 show inadequate water depth, and a construction vessel is sent to deepen the passage. The original plan of first erecting the southern wind turbines, is now abandoned. The future order of wind turbine erection will be selected in accordance with the information available from the seabed.

At 10:15 p.m. the Svitzer Survey scanning results are discussed at a meeting, and it is decided to start erecting wind turbine No. 6 the following morning, if the weather forecast holds. It is expected that the Muhubbah can be towed out and start lowering the its legs at 7 a.m.

The Heimdal is sent out to sea and spends all night checking sites Nos. 6 and 7. While Svitzer Survey performs electronic scanning, the Heimdal now mechanically checks the results by dragging a simple barrier 3.5 metres below the surface registering all hindrances above this height.

14 November:
3rd ERECTION (Turbine No. 6)
In the morning a meeting is held with the ship captains, and all agree that Svitzer Survey, following the Heimdal's mechanical double checking, will sail out and place buoys in front of the navigation channel to site No. 7, where the depth appears to be insufficient. Also, the seabed investigations will still continue with the main emphasis on the northern area.

Otherwise we are all eager to go to the Øresund, so after the meeting we quickly put on our lifejackets and board the Skagerrak to erect wind turbine No. 6

02 00 p m	The Thr sails out with components
10 00 p m	Wind turbine No. 6 is erected without complications
11 30 p m	The Thir is back at the moorage

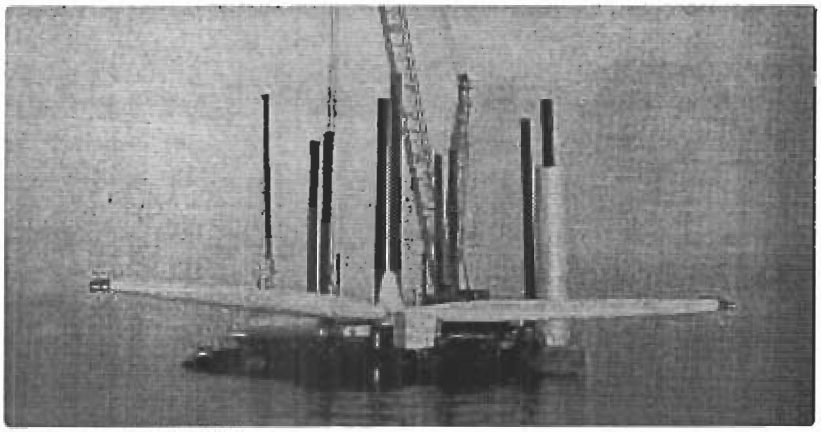
Wonderful, a trouble free wind turbine erection in the middle of all the difficulties with seabed investigations and alternative planning for future installations.

15 November:
4th ERECTION (Turbine No. 7)
The seabed investigations by Svitzer Survey continue and the Muhibbah is towed from site No. 6 to site No. 7 after a construction vessel has deepened the navigation channel. The wind turbine is then finally assembled and erected at 10 p.m.

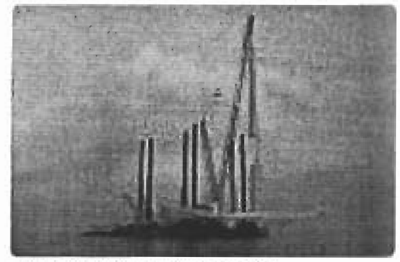
16 November:
5th ERECTION (Turbine No. 10)
Due to the risk of damaging sea cables, diver assistance is required during Muhibbah's transit from site No. 7 to No. 10

We are now behind our lift schedule, however before midnight we succeed in erecting the tower and the nacelle. In the early hours, the rotor is lifted, while the wind speed rapidly approaches the safety limit.

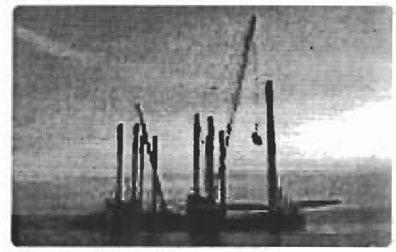
Installation by night



The Thir alongside the Muhibbah

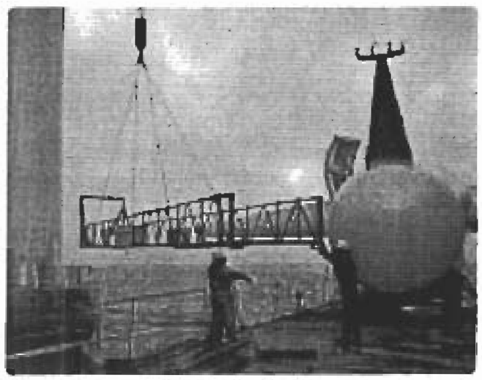


Mounting of the upper tower section

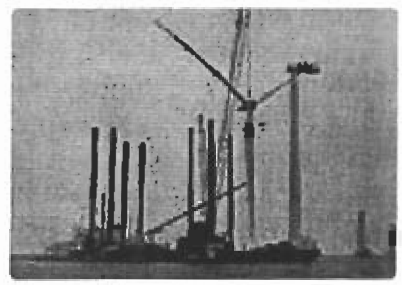


Mounting of the nacelle

The Bonus water crew enter the Muhibbah



Gangway between the Thir and the foundation



Mounting of the rotor

18-19 November:
Weekend. The weather is not suitable for installing wind turbines, so both the shore crew and the sea crew go home, while other fitters continue with the start-up work

20 November:
STRUGGLE AGAINST THE WIND AND THE WAVES
Indeed, this is the day when the Muhibbah and the Thir fight against the elements of nature. The weather conditions are very changeable, from time to time the safety limits are exceeded with wind speeds of 14-17 m/s and 3 knot currents.

However, there are also good periods, so while the Bonus fitters clear up on shore, an attempt is made to move the Muhibbah from site No. 10 to site No. 9.

This almost results in a collision with the tower, but after three attempts with additional help from an extra tug boat, we finally succeed in positioning the Muhibbah at site No. 9.

Two attempts are made by the Thir to bring the components alongside the Muhibhah, but after a few hours, the task is called off. We sail back to the harbour and wait until nightfall, when the forecast has promised an improvement in the weather

21 November:
6th and 7th ERECTION
(Turbines No. 9 and No. 11)
As forecasted, the weather has now improved, and after yesterday's half finished hardships everyone is determined that it is time for revenge.

We leave with the Thir in the early hours and are placed alongside the Muhibbah at 6:30 a.m. subsequently installing wind turbine No. 9.

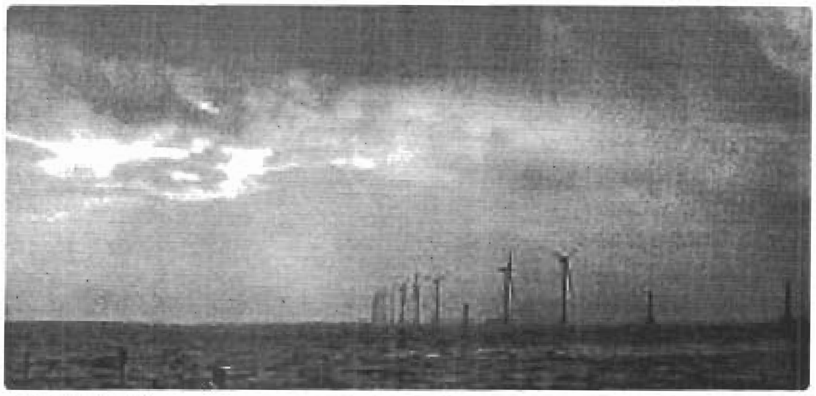
At 4 p.m. the Muhibbah is towed to site No. 1, while the Thir sails back to harbour to be re-loaded. At 9 p.m. the crew returns for the day's second erection, and at 4:30 a.m. next morning it is all over.

Returning on board the Thir, enthusiasm runs high in the little yellow hut, and the early morning coffee smells good. All expectations are fulfilled, we had a good day erecting two turbines.

22 November:
A day of preparation. The Orion has left to measure the water current, and divers checking the area on site No. 14 after removing of some stones. All results are positive and the weather forecast is also promising. We aim for another erection tomorrow.

23 November:
8th ERECTION (Turbine No. 14)
In the morning the Muhibbah is moved to site No. 14, and the Thir is sent to sea with a new load of components.

At 12:30 a.m. we leave on board the Skagerrak. Today there is no wind, and it is one of the rare days when the sun breaks through the clouds and we can see the already erected wind turbines reflected in the Øresund waters.



Thunder coming up

We cross the gangway from Thir to the foundation and look deep down into the still water. Here the water depth is four metres, and a dark green mass of eelgrass clearly shows on the seabed. A large light green circle also shows on the dark green background. This is the foundation base plate, maintaining the whole construction in its position by its own massive weight.

On site No. 14 it is late autumn, and while the suu's rays rapidly disappear, the upper tower section is lifted up, followed by the nacelle. The rest of the erection is done under floodlights, and at 10 p.m. we are almost finished.

GREETINGS FROM THE FORCES OF NATURE

The Muhibbah has lifted the rotor up in its place, and the fitters have almost finished tightening the hub bolts. Then suddenly thunder and an ugly crackling is heard from the tail vane sticking up from the nacelle, carrying wind measuring instruments and the lightning rod.

And that is exactly what it is: Lighting. In this case heavy ones. Even though there is no direct strike on the wind turbine, the high voltage potential before the lightning shows itself in this way.

The fitters do not need to be reminded of safety regulations to climb down in such situations. They take refuge in one of the designated security zones, on a platform in the tower. They sit down for the 15 minutes required by the safety regulations.

In large metal constructions, areas of different electrical voltage potential can form. Therefore, one must wait for these different voltages to be equalized before it becomes safe to move again.

There is more lightning and further waiting periods before this evening's task can be finished. The fitters are back at the hotel in Kastrup around midnight, and after a short meal and a shower, certainly the majority must have had a good night's sleep before they meet again the following morning at 6:30 a.m.

24 November:

9th ERECTION (Turbine No. 15)

The day starts blusterous with wind speeds of 12-14 m/s and currents of 1.7 knots.

We wait on stand-by as the weather forecast promises better conditions later in the day. The weather does improve, and wind turbine No. 15 is erected without problems late at night.

25-26 November:

COMPANY PARTY

The weekend has come. All Bonus employees are off work participating in a big company party in Herning Conference Centre on the occasion of Bonus' 20-year jubilee. Entertainer Thomas Eje entertains, and we dance to two bands - a welcome break for everyone.

MUHIBBAH LOSES WEIGHT

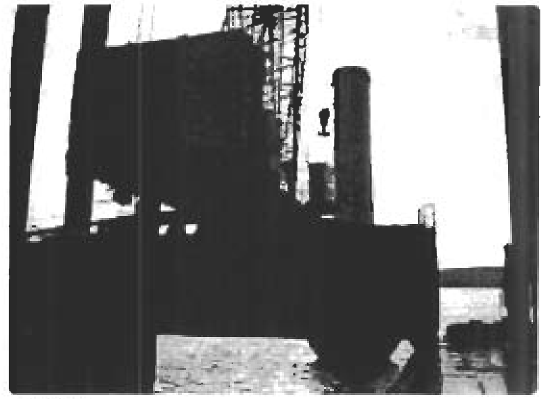
However, work still goes on at Refshaleoen. In order to lighten the Muhibbah and reduce the risk of grounding, the jack-up crane has been towed to the quay, where four of the eight legs are removed.

This is not an easy task, as each leg is half filled with water and weighs 110 tonnes. The Muhibba's own big crane lifts the legs, while a crane provided by the Krangården is placed on

The Saura Maije pushes the Thir alongside Muhibbah

The Orion pushes the Thir towards the Muhibbah

Muhibbah crane - front



Muhibbah crane - rear

the moorage helping to steer them down onto the quay.

Sunday afternoon everything is finished, and at 5:30 a.m. the next morning the Muhibbah is towed out to site No. 19 without further problems.

27 November:

10th ERECTION (Turbine No. 19)

Monday morning Bonus returns to the base with a full crew of 24 men. The day dawns with nice calm weather, a good feeling after Saturday evening's successful company party.

Most of the fitters leave with Skagerrak to start work on the erected wind turbines, while the sea crew leave on board the Thir to site No. 19, where the turbine is erected without complications.

28 November:

11th ERECTION (Turbine No. 20)

TheMuhibbah is towed from site No. 19 to site No. 20 without difficulties, and in the morning we sail out with the Thir for another wind turbine erection.

After the upper tower section and the nacelle are in place, the wind becomes too strong, and we return to harbour. At 11 p.m. we leave again and mount the rotor. We finish at 2 a.m.

29 November:

BIG PROBLEMS WITH THE MUHIBBAH

At daybreak the Muhibbah is moved from site No. 20 to site No. 17. Then the Thir is loaded and leaves later that morning for another installation.

Unfortunately there are big difficulties with the Muhibbah today, starting with certain differences of opinion between her crew and the Krangården crew concerning wind speed. A compromise is reached: 8 m/s as measured at deck-height.

The upper tower section is erected, and then real trouble starts. The wire twists when lifting the nacelle, and then the diesel engine overheats, requiring several stops during the lifting process. Usually only a couple of stops are needed enabling the engine to cool down. The lift stop and the load cells also give us problems.

The nacelle of wind turbine No. 17 is finally lifted into position, whereupon the Muhibbah is towed to the quay for a more thorough inspection. As this is expected to take a couple of days, the Thir also returns to the quay.

30 November:

Rotor No. 17 is still fastened to the elephant-foot on the Thir's deck, and as the parked trucks loaded with wind turbine components are starting to block the moorage, turbine No. 18's upper tower section and nacelle are loaded on board the Thir for storage.

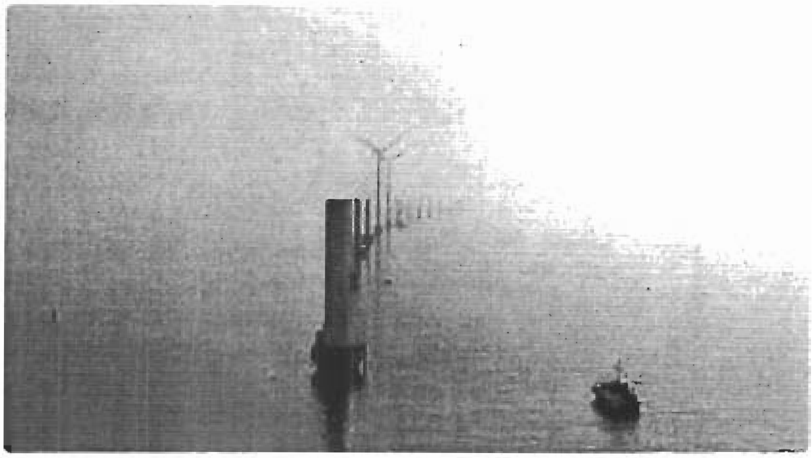
Alongside, a team from Krangården lowers Muhibbah's crane and require outside assistance to evaluate the problem.

The Thir approaches the Muhibbah

1-2 December:

The wire pully is checked for damage, and fortunately everything appears to be all right. However, the lift stop is altered, as it was incorrectly positioned.

The crane is checked by external consultants. The converter oil pressure is checked and adjusted. The load cells are faulty and are therefore adjusted and checked by a subsequent load. Later new load cells are fitted. The power supply is defect, and an electrician replaces the entire circuit around



The Ålesund on stand-by

the main switch.

Finally the crane is re-geared, giving the wire a lower gearing. This means that the Muhibbah has a higher lifting capacity, and that the strain on the winch is also reduced. Late in the afternoon all these alterations have finished, and the Muhibbah is towed out to turbine No. 17 again.

2 December:

THE TURNING POINT
12th and 13th ERECTION

(Turbines No. 17 and No. 18)

The Thir leaves in the morning and fortunately the rotor is lifted without difficulties. However, the Muhibbah's safety systems will not accept the new load cells, so the old ones are re-fitted. Even though they are not optimum, they can be used in view of the recent crane adjustments, and the work routine obtained during the project.

The Muhibbah is towed to site No. 18, while the Thir returns to harbour, still loaded with the upper tower section and the nacelle for turbine No. 18. The rotor for this turbine is loaded, and we leave again. Wind turbine No. 18 is erected at night, and we are all grateful for once again having completed two erections in one day.

The further development of the project clearly demonstrates that we have now reached a real turning point. From now on we can erect the remaining wind turbines according to routine, when the weather allows.

3 December:

Early in the morning the Thir is towed alongside the quay, and is loaded with components for wind turbine No.16. However, the Muhibbah cannot be moved due to excessive wind- and current conditions.

Fortunately, the weather changes, and at 7:30 p.m. the Muhibbah can be positioned at site No. 16. At the hub-height of 64 metres above sea level, the wind however is too strong for errecting wind turbines.

4 December:

14th ERECTION (Turbine No. 16)

The weather is good, and the Thir sets out at 6 a.m. Wind turbine No. 16 is erected without difficulties, and the Thir is towed back to be re-loaded. The Muhibbah is towed to site No. 8, which is an affair of long duration, as the weather deteriorates to conditions near the safety limits.

5 December:

ANOTHER STRUGGLE WITH THE WEATHER

This morning looks like another day of battlling with wind and current.

We are unsure of the conditions. The Orion is sent to measure the current, resulting in an extra tug boat being requested to assist the Thir's transport.

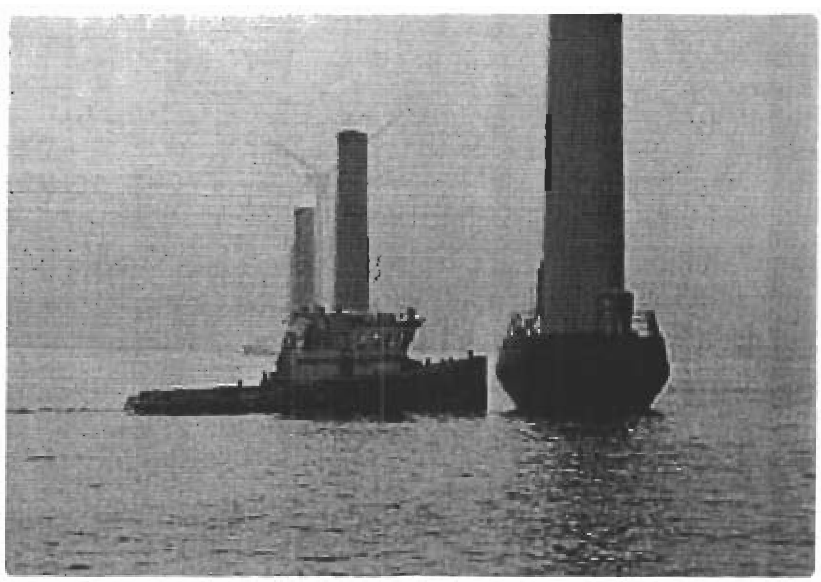
At the beginning of the afternoon the Thir lies alongside the Muhibbahh, and even though we experience wind speeds of 9-10 m/s, we succeed in erecting the upper tower section and the nacelle on site No. 8.

We go on stand-by at 5 p.m. and drink coffee in the yellow site-hut on the Thir's deck. However, at 7 p.m. the wind speed increases to 14-15 m/s, and we cancel further activities for the rest of the day.

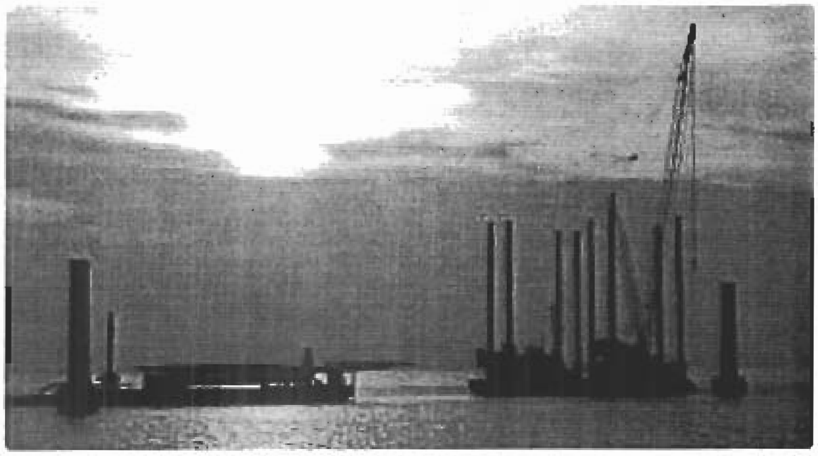
6 December:

15th ERECTION (Turbine No. 8)

Still too windy and most of the morning we wait on stand-by. Luckily, in the afternoon it dies down and we



The Orion at a foundation



The Thir and the Muhibbah

succeed in fixing the rotor on turbine No. 8. during wind speeds of 10 m/s. The Thir returns for a re-load, while the Muhibbah remains in its position at site no. 8 due to the unfavourable weather.

7 December:
16th ERECTION (Turbine No. 5)

At 6 a.m. the Orion leaves to check the current, now at one knot which is too much for the Muhibbah. So, the tug boat the Korsør is requested to assist in towing.

The Korsør arrives at 10:30 a.m., and the Muhibbah is moved from turbine No. 8 to site No. 5, where the turbine is erected without problems.

8 December:
HARD NEGOCIATIONS
17th ERECTION (Turbine No. 1)

Today we have quite tough negotiations with the Muhibbah's owner. The 40 day rental contract of the jack-up crane has now expired, and we have still not erected the four northern wind turbines

We succeed in obtaining four extra days by referring to the times when the Muhibbah due to alterations or repair, was unable to participate in the scheduled erections.

During these negotiations the weather has exceeded the safety limits, and now, as a kind of reward for the successful negotiation result, the wind speed falls to 9 m/s at 2:30 p.m. We leave with the Thir at 3 p.m., erect wind turbine No.1, and are back at the quay at 11 p.m.

9 December:
EFFICIENT RELIEF CREW
18th and 19th ERECTION
(Turbines No. 4 and No. 3)

Most of the crew is free for the weekend and is replaced by relief crews from the Bonus service and production section. All former fitters, eager to demonstrate that they can still erect turbines.

The Muhibbah moves to site No. 4 at 6 a.m., and an hour later the Thir is loaded. During the morning wind turbine No. 4 is erected without difficulties.

Now we start on No. 3. The Muhibbah starts to move, and the Thir returns to the quay for re-loading. Early next morning wind turbine No. 3 is erected.

For the third time we have erected two wind turbines in a single day.

10 December:
GOOD INTENTIONS
AND A WASTED DRIVE

While the relief crew sits drinking morning coffee on their way back to shore after the erection of the last but one wind turbine, the wind starts to blow harder. The Muhibbah's crew wants to seek shelter in the harbour, as they cannot jack the platform out on the troubled waters with only four remaining legs.

With prospects of slightly more favourable weather our project-manager convinces the Muhibbah's crew to stay put. The Thir is also situated at the moorage fully loaded.

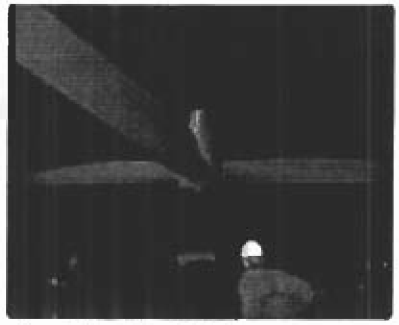
We are all eager to erect the final turbine, but during the evening the relief crew drives back home due to the continously bad weather.

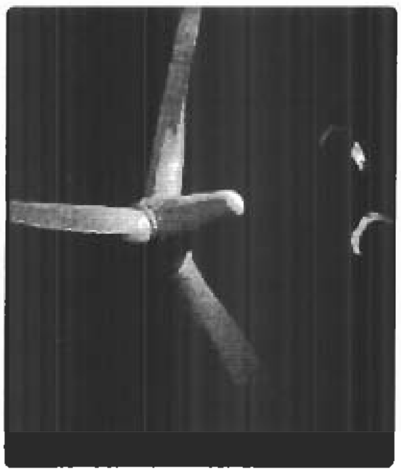
At Refshaleøen, the project manager looks for new opportunities, and as the crew approaches the Storebælt Bridge, between the islands of Zealand and Fynen, he calls and asks them to return, as conditions are looking better.

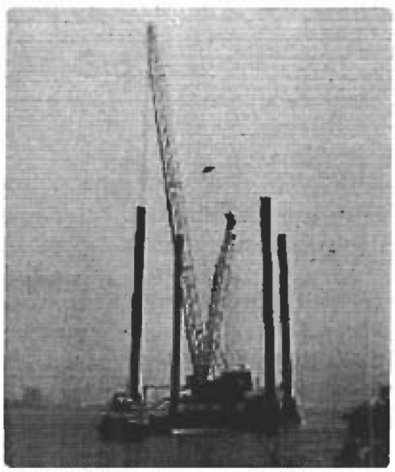
Unfortunately, the current increases, and near Copenhagen counter-orders are given, and the crew finally turns home towards Jutland after a good weekend.

Bonus 2 MW offshore - with the cooperating utility plant the Amagerværket in the background


The crane hook and the lifting fittings on the hub


The rotor leaves the elefant-foot


The final lift


The Muhibbah along the moorage for the last time

11 December:
ONE TURBINE REMAINING

The next morning we drive towards the base at 6:30 a.m. It is not the usual sight. We meet no rows of transport trailers with wind turbine components. The quay looks empty. Alongside the quay the Thir waits looking almost alone and abandoned, loaded with the rotor, the tower section and the nacelle.

The last wind turbine has to be erected, and at 7:15 a.m. nine people from Bonus and Krangården climb on board the Thir. She leaves, as usual pushed out by the Sara the Maatje with the Orion alongside. The erection starts at 8:30 a.m. and simultaneously the dawn opens a dark-grey and windy day.

The wind speed is constantly increasing, and when the nacelle is in place at noon, it exceeds 10 m/s. The Muhibbah's crew shows by eager hand signals that we must hurry-up and lift the rotor. However, the site manager complies with the safety regulations and declines. The rotor must wait.

It is a bit irritating to wait on stand-by with the final erection not finished, and we wait longer than usual. However, the wind constantly increases, so we return to shore on board the Skagerrak.

Back on the quay, the project manager has ordered large open sandwiches expecting to celebrate the final erection. We eat them in the fitters site hut, and in spite of everything they taste good.

However, the site manager does not have much to eat, hanging on the telephone having long and very detailed discussions with the meteorological center in Karup. The strong winds will continue, but early tomorrow morning between 4 a.m. and 5 a.m., we should have a short period with wind speeds under 10 m/s.

12 December:
20th INSTALLATION (Turbine No. 2)

It was a short night in the small hotel room. We are up at 2:45 a.m. and look out of the window. Fortunately, as foreseen, the wind has decreased, and at 3:30 a.m. we leave the Refshaleoen on board the Skagerrak

We enter the Thir, start up the cranes and the rotor lift. It is pitch-dark, but white floodlights follow the rotor, as it goes up. Attachment and successful fastening are completed at 5:30 a.m. The last wind turbine is now finally erected.

One might have thought that a certain enthusiasm would be shown, but the fitters are mostly eager to return back to the hotel to have breakfast. They leave on board the Skagerrak, while the rest of us return to shore with the Thir. Here the mood is almost a little melancholic.

The wind speed has now dropped further, and suddenly everything is quiet, while we sail north of Trekroner for the last time and slowly glide into the harbour past the Langelinie. Here floodlights from the many construction sites show craftsmen busy building new offices and exclusive apartments.

We however are finished with our construction activity, and soon we are back along the Refshaleoen moorage Before long the Krangården team starts removing their equipment from the Thir.

Later in the morning the wind increases, while the Muhibbah appears from the mist and is towed along the moorage for the last time.

THE END

This evening Bonus invites their crews and other partners for a good meal at the Lynetten Restaurant. The mood is cheerful and relaxed, and the 47 workers congratulate each other and celebrate that the wind turbines, in spite of all difficulties, have been erected on schedule.

We drive back to the hotel at 11:30 p.m. in a specially ordered bus. The Krangården team however are not quite "finished" with the evening, and they succeed in persuading the Orion's skipper to pick them up at the Lynetten and sail them into the heart of Copenhagen. Rumours relate that for the rest of the night the Orion was"parked" in Nyhavn, right in the middle of the harbour bar-area.

CABLE-LAYING

The Henry P. Lading - large turntable under the wheelhouse - cables are led out from astern

The generator in the nacelle of the Bonus 2 MW wind turbine produces 690 Volt alternating current, which is sent to the transformer in the tower base section. The current flows in three 1.500 mm² cables, each carrying 1.700 Amperes at full load.

The transformer raises the voltage from 690 Volts to 30.000 Volts, and the current is thus reduced in opposite ratio from 1.700 Amperes to 39 Amperes. This enables the use of three relatively thin 150/240 mm² cables for the transportation of power to shore. The sea-cables are connected to the Amagerværket, a utility operated power plant. From here power is sent to the public grid.

Bonus and KK Electronics install the cables from the wind turbine generator to the control systems in the tower base section. Then NKT Cables take over, and install the high voltage connection from the transformer and the coupling through the sea-cables and up to the Amagerværket.

NKT Cables play an important role in this part of the project. Apart from the cable connections, the NKT makes and lays their own cables, and with Siemens as sub-contractor they supply and install the transformers and the coupling systems.

CABLE-LAYING

At the NKT factory in Kalundborg 21 cables for the project are made . They are delivered to the cable-laying vessel Henry P. Lading, where they are wound onto a large turntable, in the order in which they will later be laid out.

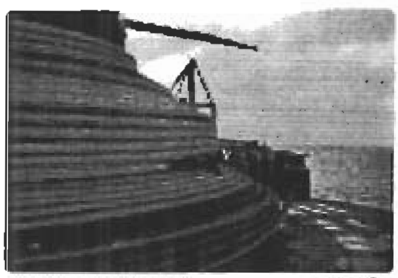
The vessel Henry P. Lading is towed to the Middelgrunden by three tug boats, as it lacks propulsive power.

The cables are laid between the wind turbines in a half a metre metre deep trench. From the site to the shore the sea-cables are buried in a one metre deep trench, which has also been dug out by hydraulic excavators.

However, the cable trench in the Kongedybet navigation channel is washed down into the seabed. After the cables are laid, the trenches are re-filled with the excavated material.

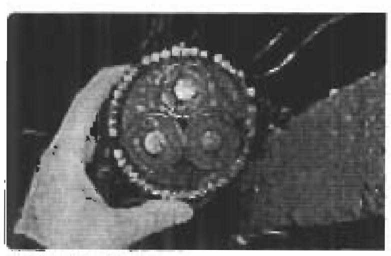
When Henry P. Lading is in position, the cable is first laid out on air bags floating in the water. A speedboat aligns the cable above the excavated trench, and a diver working on the surface lets the air out from each bag in turns. The cable then slowly sinks down, and is guided into place by another diver on the seabed. He is in radio contact with the crew in the speedboat.

The diver then drags the end of the cable to the cable-conduit on the foundation (see drawing on page 19) and ties it to a wire sticking out. A winch placed in the tower base section now pulls the sea-cable through the foundation into the tower. Here it is connected to the wind turbine electrical system.

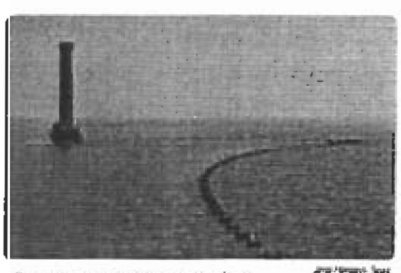


Turntable with sea-cables

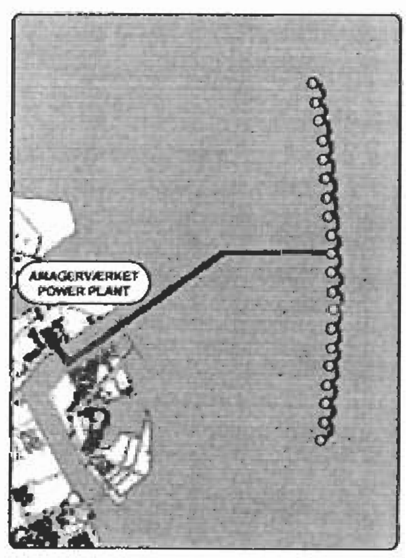
Sea-cable being mounted into air bag



Sea-cable section



Boat places sea-cables in air bag



On-shore connection